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Geology of the Squaw Lake – Sturgeon Lake Area District of Thunder Bay

by
N.F. Trowell

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CONTENTS

	Page
Abstract	ix
Introduction	1
Acknowledgments	1
Means of Access	1
Prospecting and Mining Activity	3
Present Geological Survey	3
Previous Geological Work	3
Renewable Natural Resources	4
Physiography	4
General Geology	5
Early Precambrian	8
Metavolcanics and Metasediments	8
Metavolcanics	8
Mafic to Intermediate Metavolcanics	9
Massive Flows	9
Porphyritic Flows	9
Pillowed Flows	13
Hyaloclastite (Pillow Breccia) Units	15
Autoclastic Breccia, Vesicular and Amygdaloidal Flows	16
Pyroclastic Rocks	16
Amphibolite	17
Felsic to Intermediate Metavolcanics	18
Pyroclastic Rocks	19
Mode of Deposition	22
Spherulitic Tuff	28
Porphyry	28
Felsite	29
Carbonate Breccia Unit	29
Petrography	32
Origin of the Carbonate Breccia Unit	33
Metasediments	36
Sandstone	37
Siltstone, Argillite	37
Knotted Metasediments	38
Conglomerate	40
Iron Formation	40
Metamorphosed Mafic Intrusive Rocks	43
Gabbro, Diorite	44
Porphyritic Gabbro, Anorthositic Gabbro, Diorite	44
Felsic Intrusive Rocks	48
Granitic Complexes	48
Eastern Granitic Complex	48
Western Granitic Complex	49
Massive Trondhjemite, Porphyritic Trondhjemite	50
St. Anthony Pluton	51
Vista Lake, Flindt River, Vanessa Lake Intrusions	51
Vista Lake Intrusion	51
Flindt River Intrusion	52
Vanessa Lake Intrusion	53
Intermediate and Alkalic Intrusive Rocks	54
Sturgeon Narrows Alkalic Complex	55
Fenitization	57
Squaw Lake Alkalic Complex	57
Petrology	60
Mineralogy	61
Alkalic Phase	61
Border Zone	65

Quaternary 66
Pleistocene 66
Recent 66
Correlation of Geology with Aeromagnetic Data 67
Structural Geology 68
Minor Structures 68
Foliation, Schistosity, Crenulation 68
Gneissic Structure 68
Lineation 69
Boudinage Structure 69
Trachytoidal Texture 69
Kink Folds, Kink Faults 69
Folding 70
Faulting and Cataclasis 72
Economic Geology 74
Gold 74
Quartz-Carbonate Veins 74
Sulphides, Sulphide Iron Formation 76
Fluorite 76
Magnetite 77
Radioactivity 77
Uranium and Niobium 77
Description of Properties 77
Amax Exploration Inc. [1971] (1) 81
Beckett, P.V. (2) 81
Bordun Mining (Quebec) Limited [1971] (3) 81
Bucke, H.W.W. (4) 81
Canadian Nickel Co. Ltd. [1969] (5) 82
Can-Con Enterprises and Exploration Limited (St. Anthony Mine) (6) 82
History and Development 82
Geology and Mineralization 83
Conwest Exploration Co. Ltd. [1971] (7) 86
Fortier, C. (8) 87
Grannis, F.H. (Symmes Occurrence) [1972] (9) 87
Hannula, L. (10) 87
Johnson, S. (11) 87
Davidson Carr Occurrence 87
Powell Occurrence 88
Kerr Addison Mines Ltd. [1972] (12) 88
Koval, D. (Anglo Canadian Occurrence) (13) 92
Kratzendein, B. (14) 93
Larchmont Mines Ltd. [1971] (15) 93
Mattagami Lake Mines Ltd. (16) 93
McRae Mining Corp. Ltd. [1970] (17) 94
O'Flaherty, K. (18) 94
Omar Exploration Inc. [1970] (19) 94
Phelps Dodge Corp. of Canada Ltd. (20) 94
Pomac Mines Ltd. (21) 95
Rowland, E.R. (22) 96
Royex Mining Ltd. [1972] (23) 96
Scobie, W. [1972] (24) 97
Selco Exploration Co. Ltd. [1970] (25) 97
Silverside Mines Ltd. [1971] (26) 98
Spooner Mines and Oils Ltd. [1972] (27) 98
Steep Rock Iron Mines Ltd. (28) 98
Steine, M. (29) 99
Sturgex Mines Ltd. [1972] (30) 99
Tay River Mines Ltd. [1971] (31) 99
Theriault, A. *et al.* [1970] (32) 100
Utica Mines Ltd. [1970] (33) 100
Western Quebec Mines Co. Ltd. [1971] (34) 100
Miscellaneous Occurrences 100

Considerations in Future Exploration 101
References 102
Index 107

TABLES

1. Base metal sulphide deposits in the Sturgeon Lake region 2
2. Lithologic units in the Squaw Lake-Sturgeon Lake area 7
3. Major and trace element analyses and normative mineralogy of metavolcanics 10
4. Classification of carbonate breccia unit using Silvestri's classification 30
5. Major and trace element analyses of carbonate breccia 34
6. Average and maximum values of trace element analyses of grab samples from carbonate breccia unit 35
7. Major and trace element analyses and normative mineralogy of gabbro and diorite 46
8. Major and trace element analyses and normative mineralogy of a sample from the Vanessa Lake Intrusion 54
9. Major and trace element analyses and normative mineralogy of samples from the Sturgeon Narrows Alkalic Complex 58
10. Major and trace element analyses and normative mineralogy of samples from the Squaw Lake Alkalic Complex 62
11. Geology and mineralogy of selected gold occurrences 75
12. Summary of exploration work in the Squaw Lake-Sturgeon Lake map-area 78
13. Gold and silver production at the St. Anthony Mine 83
14. Trace element analyses of altered rocks at the St. Anthony Mine 86

FIGURES

1. Key map showing location of the map-area viii
2. Lithologic assemblages in the metavolcanic-metasedimentary belt 5
3. Sections of subaqueous pyroclastic flows 24
4. Geological sketch map of St. Anthony Mine 85
5. Geological sketch map, by Graham (1931), of Davidson Carr occurrence 89
6. Geological sketch map, by the author, of Davidson Carr occurrence 90
7. Geological sketch map of Powell occurrence 91

PHOTOGRAPHS

1. Porphyritic pillowed lava 13
2. Pillow masses or tubes in mafic to intermediate metavolcanics 14
3. Contorted pillow selvages in mafic to intermediate metavolcanics 14
4. Vesicular pillowed flow in mafic to intermediate metavolcanics 15
5. Isolated and broken pillow breccias in mafic to intermediate metavolcanics 16
6. Broken pillow breccia hyaloclastite 17
7. Felsic to intermediate lapillistone to tuff-breccia 21
8. Photomicrograph of felsic ash tuff 22
9. Mixed felsic to intermediate tuff-breccia 23
10. Mixed breccia subunit of carbonate breccia unit 31
11. Layered breccia subunit of carbonate breccia unit 32
12. Photomicrograph of feldspathic wacke in contact with siltstone 38
13. Soft-sediment deformation structures in siltstone-argillite 39
14. Large block of agglomerate set in conglomerate 41
15. Sedimentary inclusions in mafic to intermediate volcanic flow 42
16. Porphyritic anorthositic gabbro 45
17. Mafic inclusions in outer syenite of Sturgeon Narrows Alkalic Complex 56
18. Kink fold in felsic crystal tuff 70

19. Isolated fold in felsic to intermediate pyroclastic rocks 71
20. Flexural-slip fold in siltstone-argillite 72
21. Box fold produced by plastic deformation 73

MAP
(back pocket)

Map 2420 (coloured) — Squaw Lake, District of Thunder Bay.
Scale 1:31 680.

Conversion Factors for Measurements in Ontario Geological Survey Publications

If the reader wishes to convert imperial units to SI (metric) units or SI units to imperial units the following multipliers should be used:

CONVERSION FROM SI TO IMPERIAL			CONVERSION FROM IMPERIAL TO SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
			LENGTH		
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
			AREA		
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
			VOLUME		
1 cm^3	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.308 0	cubic yards	1 cubic yard	0.764 555	m^3
			CAPACITY		
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
			MASS		
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
			CONCENTRATION		
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy)/ton (short)	20.0	pennyweights/ton (short)
1 pennyweight/ton (short)	0.05	ounce (troy)/ton (short)

NOTE—Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries published by The Mining Association of Canada in cooperation with the Coal Association of Canada.

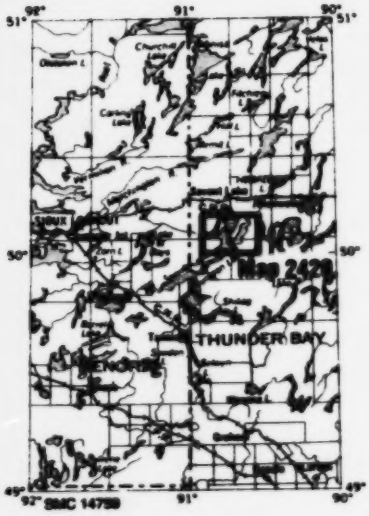

Figure 1. *Key map, showing location of the Squaw Lake-Sturgeon Lake area.*

ABSTRACT

The Squaw Lake-Sturgeon Lake area (Figure 1) covers about 460 km² in the District of Thunder Bay, about 100 km northeast of Ignace. It lies within the Early Precambrian, Wabigoon Belt of the Superior Province of the Canadian Shield. Within the map-area the metavolcanic-metasedimentary sequence is approximately 19 km long by 12 km wide, and is bounded on both sides by intrusive, composite, granitic complexes.

The metavolcanic-metasedimentary sequence has been subdivided into ten lithologic, in part lithostratigraphic, assemblages. While several cycles of volcanism are represented, the actual breakdown into individual cycles is hampered by the frequent alternation of units of distinctly different composition suggestive not only of multicyclic volcanism but also possibly of concurrent felsic and mafic volcanism.

The metavolcanic-metasedimentary sequence and associated mafic intrusive bodies have been complexly folded and faulted, regionally metamorphosed under greenschist and amphibolite facies conditions, contact metamorphosed under hornblende hornfels facies conditions, and internally intruded by granodioritic and alkalic complexes.

The former St. Anthony Mine, which operated intermittently from 1905 to 1941 and produced gold and silver valued at $2,165,292, is located in the west-central portion of the map-area. Several gold and sulphide occurrences have been described, though none are presently economic. The Sturgeon Lake region is known now for its base metal massive sulphide deposits. Recent exploration in the map-area has primarily concentrated on the search for similar base metal deposits, but several old gold occurrences have also been restaked and re-examined.

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Geology of the Squaw Lake — Sturgeon Lake Area

District of Thunder Bay

by N.F. Trowell[1]

INTRODUCTION

The Squaw Lake-Sturgeon Lake area is about 100 km northeast of Ignace and covers 460 km^2, bounded by Latitudes 50°00′ and 50°09′30″N and by Longitudes 90°28′ and 90°50′W. The area was surveyed during 1972 and 1973, the sixth and seventh years of geological mapping by the author in the Sturgeon Lake metavolcanic-metasedimentary belt. Adjacent and nearby areas were described in previous reports (Trowell 1970, 1974a, 1974c, 1976).

The Squaw Lake-Sturgeon Lake area is part of the Early Precambrian Wabigoon Belt of the Superior Province of the Canadian Shield. Mineral exploration began in 1899 (McInnes 1902) when gold was first discovered in the area. From 1905 to 1941 the St. Anthony Mine produced gold and silver valued at $2,157,823 and $7,469 respectively (Ferguson *et al.* 1971).

ACKNOWLEDGMENTS

Assistance in the field was provided by L.G. Stephenson, R.C. Lelievre, W.D. Gordanier and C. Craig in 1972, and by G.W. Einarson, D. Ference, R. George, and W.D. Gordanier in 1973. Stephenson and Einarson, as senior geological assistants, were responsible for approximately half of the mapping.

MEANS OF ACCESS

The road nearest to the map-area is Highway 599 which provides access to Sturgeon Lake. It extends northeast from Ignace and passes less than 1.5 km from the western border of the map-area.

The western half of the area can be reached by boat on Sturgeon Lake. In the eastern half of the area, a portage connects Sturgeon and Squaw Lakes, while portages from Squaw Lake to Vista Lake and from Vista Lake to the Flindt River and thence to Vanessa Lake connect all the major lakes in this area. For the eastern portion of the area, access is easiest by float equipped aircraft which can be chartered at Savant Lake, Sioux Lookout, and Ignace.

Care should be exercised on Sturgeon Lake as high winds are common and violent storms do occur. In July of 1973, a severe storm accompanied by winds estimated in excess of 200 to 240 km/h struck the Northeast Arm and Couture Lake area and almost totally

[1]Geologist, Ontario Geological Survey, Toronto. Manuscript approved for publication by the Chief Geologist, Ontario Geological Survey, March 18, 1977. This report is published with the permission of E.G. Pye, Director, Ontario Geological Survey.

TABLE 1. BASE METAL MASSIVE SULPHIDE DEPOSITS IN THE STURGEON LAKE REGION OF NORTHWESTERN ONTARIO (BARLOW 1974).

Owner	Deposit Name	Discovery Date	Deposit Type	1974 Tonnage Estimate (million tons)	Average Grade					Development		
					Zn (%)	Cu (%)	Pb (%)	Ag (oz/ton)	Au (oz/ton)	Mode	Production (tons/day)	Strike Length (feet)
Mattabi Mines Ltd.	Mattabi	1969	Zn-Cu-Pb-Ag-Au	12.8	7.60	0.91	0.84	3.13	0.007	Open Pit	3,000	1,800
Sturgeon Lake Mines Ltd.	Boundary	1970	Zn-Cu-Pb-Ag-Au	2.1	10.64	2.98	1.47	6.14	0.02	Open Pit	1,200	1,000
Mattagami Lake Mines Ltd.	Lyon Lake	1971	Zn-Cu-Pb-Ag-Au	1.1	6.81	1.03	0.59	2.96	0.007	Under-ground	1,000	1,400
Mattagami Lake Mines Ltd.	Creek	1972	Zn-Cu-Pb-Ag-Au	0.9	8.84	1.66	0.76	4.71	0.019	Under-ground	—	700
Mattagami Lake Mines Ltd.	Group F	1970	Zn-Cu-Ag-Au	—	—	—	—	—	—	—	—	400

destroyed 1,000 acres of forest. Several tornado scars giving witness to previous wind storms were observed on the air photos and in the field.

PROSPECTING AND MINING ACTIVITY

W. McInnes (1902, p.115A-122A) reported that gold-bearing quartz veins were discovered on Sturgeon Lake, in the summer of 1898, by a prospector named Peter King and that a number of claims were staked. Intermittent exploration for gold was carried out during the next few years. The construction, in 1909, of the Lake Superior Branch of the Grand Trunk Pacific Railway, and the establishment of steamer routes on Sturgeon Lake to facilitate transportation of materials for railway construction, resulted in increased though temporary exploration activity.

During the period 1905 to 1941, the St. Anthony Mine produced gold and silver valued at $2,157,823 and $7,469 respectively (Ontario Geological Survey, Source Mineral Deposit Record, St. Anthony Gold Mines Limited, Northern Gold Reef Limited).

A surge of exploration activity began in 1969-1970 following the discovery of a base metal sulphide deposit, in October 1969, by Mattagami Lake Mines Limited (now Mattabi Mines Limited) on Block No.7 of land held by Abitibi Paper Company Limited. Exploration led to the discovery of other base metal deposits (Table 1). A renewed interest in gold in the 1970s led to the restaking of several old gold showings developed during the early days of exploration in the area.

PRESENT GEOLOGICAL SURVEY

The area was mapped during the summers of 1972 and 1973. Wherever possible, pace-and-compass traverses were run perpendicular to the regional trend and were spaced 300 to 400 m apart. The geological field data were plotted on acetate sheets attached to air photographs at a scale of 1 inch to ¼ mile. These data were then transferred to a base map at the same scale, prepared by Cartography Section, Surveys and Mapping Branch, from maps of the Forest Resources Inventory.

Information from property plans and diamond-drill hole logs filed for assessment work (Assessment Files Research Office, Ontario Geological Survey, Toronto), and information from aeromagnetic maps and ground magnetic maps (Barlow 1974a,b, 1975a,b) was also used in the preparation of this report.

Uncoloured preliminary maps (Trowell 1973, 1974b) at a scale of 1 inch to ¼ mile were published after the completion of field work, and the final coloured map (Map 2420, back pocket) was published at a scale of 1 inch to ½ mile.

PREVIOUS GEOLOGICAL WORK

W. McInnes (1900) of the Geological Survey of Canada was presumably the first geologist to describe the Sturgeon Lake area. E.J. Davidson (1901, p.207-250) described the area in the "Report of the Survey and Exploration of Northern Ontario". A.P. Coleman (1902, p.147-149) reported on some of the gold prospects on Sturgeon Lake. W.G. Miller (1903, p.82-87, p.104, 105) described the workings on many of the claims on Sturgeon Lake. W.H. Collins (1907, p.103-109) mapped the geology of the area between Lake Nipigon and Sturgeon Lake. E.T. Corkill (1906, p.59; 1907, p.60; 1908, p.64-66; 1909, p.81, 82; 1910, p.79; 1911, p.87; 1912, p.102, 103; 1913, p.99) in his position as Inspector of Mines gave brief descriptions of the mines on Sturgeon Lake. E.S. Moore (1911, p.133-157), T.L. Gledhill (1925, p.18-39), and A.R. Graham (1931, p.36-50) gave fairly detailed descriptions of the geology of Sturgeon Lake. Though not necessarily covering the present map-area, T.L. Tanton (1940), D.P. Rodgers (1964), and R. Skinner (1969) have given the most recent descrip-

tions of the general Sturgeon Lake region. F.J. Pettijohn (1937) made brief mention of the general Sturgeon Lake area in his discussion of the "Northern Subprovince" of the Lake Superior region

RENEWABLE NATURAL RESOURCES

Trees found in the area include jackpine, spruce, poplar, balsam, tamarac, birch, and alder. Cedar along with alder are prominent in the swamp areas while balsam, tamarac, and spruce grow in the low-lying areas. No harvesting is being carried out at present and only small isolated areas show evidence of having been cut over, specifically in the area of old workings such as the St. Anthony Mine.

The Sturgeon Lake area has long been a popular tourist area, and several lodges and tourist camps are located within the area. Northern pike, pickerel, and lake trout are the main catches during the fishing season. Moose and bear hunting is carried out during the provincial hunting season, and fur-bearing animals are trapped in the general Sturgeon Lake-Savant Lake area.

PHYSIOGRAPHY

The elevation of Sturgeon Lake is 409 m above sea level, and the maximum local relief is never more than 100 m above this elevation. Higher elevations occur along the faulted contact zone between the metavolcanic-metasedimentary sequence and the eastern granitic batholithic complex, and in areas of massive rock of approximately uniform composition, such as the Sturgeon Narrows Alkalic Complex.

The present map-area lies primarily within the drainage basins of the English River and its tributary, the Sturgeon River. The above mentioned contact between the metavolcanic-metasedimentary belt and the eastern granitic complex marks a river-system divide with the waters to the west flowing west into Lake Winnipeg and those to the east to the Albany River. The entire region has been glaciated; the deeper lakes occur in glacially deepened basins in the bedrock, and the shallower lakes in depressions in the glacial deposits themselves.

Outcrop distribution is variable but generally abundant, although outcrop is scarce in the areas underlain by the metasedimentary assemblage and the eastern granitic complex northeast of Vista Lake.

GENERAL GEOLOGY

In the map-area an Early Precambrian metavolcanic-metasedimentary sequence forms a northeast- to north-trending belt that averages 12 km wide and within the map-area has a strike length of approximately 19 km. It is bordered on both the east and west by two composite granitic complexes, herein referred to as the eastern and western granitic complexes respectively. Both complexes extend outside of the present map-area. The lithologic units of the Squaw Lake map-area are listed in Table 2.

The metavolcanic-metasedimentary sequence has been subdivided, from west to east, into 10 assemblages (Figure 2), primarily on the basis of the dominant lithology present.

Assemblage A comprises east-facing mafic to intermediate metavolcanics of tholeiitic kindred, and is about 3000 m thick. The metavolcanics are composed predominantly of flows, both massive and pillowed, and mafic intrusive equivalents. Thin intercalated units of argillite, and graphitic sulphide zones appear approximately 1220 m upsection and mark local hiatuses in volcanism and volcanogenic exhalative activity respectively. The presence of mafic to intermediate pyroclastic rocks and volcanogenic sedimentary rocks along

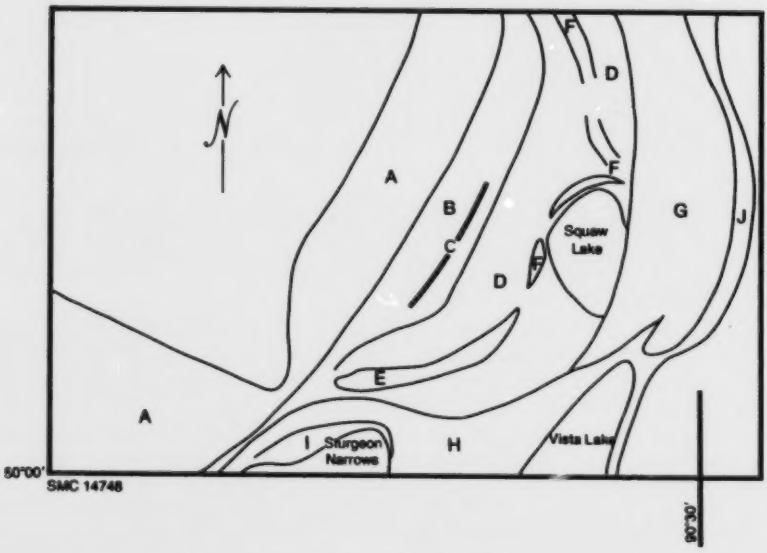


Figure 2. *Schematic sketch showing subdivision of metavolcanic-metasedimentary sequence into 10 lithologic assemblages.*
A Mafic to intermediate metavolcanics
B Felsic to intermediate pyroclastic rocks
C Carbonate breccia unit
D Mafic to intermediate metavolcanics
E Felsic to intermediate pyroclastic rocks
F Felsic to intermediate pyroclastic rocks
G Mafic to intermediate metavolcanics
H Metasediments
I Mafic to intermediate metavolcanics
J Mafic to intermediate metavolcanics

the north portion of Couture Lake suggests that a subsidiary volcanic vent was located in this area. Towards the top of assemblage A, pyroclastic and hypabyssal intrusive rocks of intermediate composition are intercalated within the metavolcanic flows and mark the onset of a period dominated by intermediate to felsic volcanism. Pillow structures in assemblage A flow units change, from bottom to top, from mattress shaped, non-amygdaloidal, to bun-shaped amygdaloidal, suggestive perhaps of a change from deep to shallow water depositional environment.

Assemblage B is composed predominantly of intermediate to locally felsic pyroclastic rocks of tholeiitic to calc-alkalic (high alumina) kindred and derived volcanogenic metasediments. Thin, intercalated, mafic to intermediate metavolcanic flows are common, indicating that mafic volcanism was occurring concomitantly. The general trend from bottom to top of this assemblage is one of increasing silica. Assemblage B appears to attain its maximum thickness in the Morgan Island area where it is approximately 2400 m thick though portions are possibly repeated by faulting or folding. In this area also, the pyroclastic units contain their largest fragments indicating perhaps that this was an original centre of accumulation or vent area. Towards the top of this assemblage and along strike from this possible vent area, volcanogenic metasediments possibly reflect a subaqueous pyroclastic flow-sedimentary regime.

Assemblage C which lies near or at the top of assemblage B consists of carbonate breccia. The author believes the breccia unit may be an Early Precambrian example of hyaloclastic volcanism. This unit is a few metres to more than 200 m thick and, like assemblage B, attains its maximum thickness in the Morgan Island area.

Assemblage D is composed of east-facing mafic to intermediate, predominantly pillowed and amygdaloidal volcanic flows with thin felsic to intermediate pyroclastic units. Pillow breccia hyaloclastite units are of the variety formed in shallow water. This assemblage is approximately 3000 m thick.

Assemblage E is composed of intermediate to locally felsic pyroclastic units and is approximately 700 m thick north of Coveney Island. Assemblage F consists of scattered intercalated units in assemblage D and may be the lithostratigraphic equivalent of assemblage E. The configuration of assemblage F is possibly caused by the intrusion of the Squaw Lake Alkalic Complex, folding or a combination of both.

Assemblage G is composed of apparently east-facing mafic to intermediate metavolcanics and thin intercalated metasedimentary units; it attains a maximum thickness of 4900 m. Assemblage G overlies the felsic metavolcanic assemblages E and F and thus may represent a third cycle of mafic volcanism separate from assemblage D.

Assemblage H is the main sedimentary succession in the area. It is approximately 900 m thick and possibly represents an off-lapping sequence to the previously described assemblages. The earliest members of assemblage H were laid down contemporaneously with the waning stages of mafic volcanism (assemblage G). Contact relationships with the metavolcanics are both conformable and unconformable, suggesting contemporaneous erosion and deposition, on the central and flank positions respectively, of an original volcanic edifice. Both east- and west-facing measurements were obtained suggesting synclinal folding of this assemblage.

Assemblage I is composed of mafic to intermediate metavolcanics located on Coveney Island and the area to the south (see Trowell 1976), and possibly overlies assemblage H.

Assemblage J comprises amphibolite facies metavolcanics which attain a thickness of 600 m. A portion of these amphibolitized mafic metavolcanics may be correlative to the Jutten metavolcanics in the Savant Lake area as mapped by Bond (1979) and if so could represent the oldest metavolcanic assemblage in the area.

The metavolcanic-metasedimentary sequence has been extensively intruded by gabbro-diorite sills, dikes, and irregular masses. These bodies appear to have intruded prior to

TABLE 2. LITHOLOGIC UNITS FOR THE SQUAW LAKE—STURGEON LAKE AREA.

CENOZOIC
QUATERNARY
PLEISTOCENE AND RECENT

Swamp accumulations; sand and gravel.

Unconformity

EARLY PRECAMBRIAN (ARCHEAN)
INTERMEDIATE AND ALKALIC INTRUSIVE ROCKS
SQUAW LAKE ALKALIC COMPLEX

Alkali feldspar syenite; foid and/or zeolite syenite and monzosyenite; pegmatoid syenite; lamprophyre; inclusion syenite; monzonite, monzosyenite.

STURGEON NARROWS ALKALIC COMPLEX

Biotite-pyroxene, pyroxene syenite; biotite, biotite-pyroxene nepheline syenite; garnet-nepheline syenite, nepheline-garnet syenite; leucocratic nepheline syenite; muscovite leucosyenite; lamprophyre; perthite porphyry; xenolithic alkalic syenite; syenodiorite, syenogabbro; xenolithic syenodiorite and syenogabbro; syenite, syenodiorite.

Intrusive Contact

FELSIC INTRUSIVE ROCKS
VISTA LAKE, FLINDT RIVER, VANESSA LAKE INTRUSIONS

Porphyritic hornblende, biotite-hornblende granodiorite; hornblende, biotite-hornblende granodiorite; quartz monzonite, monzonite; pegmatite; leucocratic granodiorite, monzonite; aplite, feldspathic mobilizates.

Intrusive Contact

GRANITIC COMPLEXES

Quartz lenticule, biotite, hornblende-biotite, biotite-hornblende, hornblende granodiorite, trondhjemite; porphyritic (porphyroblastic) granodiorite, trondhjemite; massive trondhjemite, granodiorite; xenolithic granodiorite and trondhjemite; pegmatite; feldspathic mobilizates.

Intrusive Contact

METAMORPHOSED MAFIC INTRUSIVE ROCKS

Gabbro, diorite; feldspar-porphyritic gabbro, diorite; amphibole-porphyritic gabbro; feldspar-porphyritic anorthositic gabbro, diorite.

Intrusive Contact

METAVOLCANICS AND METASEDIMENTS
METASEDIMENTS

Wacke, arenite; siltstone, argillite; conglomerate; ferruginous metasediments; metasedimentary schists and gneisses; chert; paramphibolite; knotted metasediments; migmatitic metasediments; fenitized metasediments.

METAVOLCANICS
CARBONATE BRECCIA UNIT

Mixed breccia subunit; layered breccia subunit, isolated breccia subunit.

FELSIC TO INTERMEDIATE METAVOLCANICS

Flows, porphyritic flows, tuffs; crystal, lithic-crystal tuff; autoclastic breccia; chert; tuff; lapilli-tuff, lapillistone; tuff-breccia; pyroclastic breccia; quartz-feldspar porphyry, feldspar-quartz porphyry; felsite; spherulitic flows; schists, phyllites.

MAFIC TO INTERMEDIATE METAVOLCANICS

Flows; porphyritic flows; tuff, lapilli-tuff, lapillistone; autoclastic breccia; hyaloclastites; pillowed flows; amygdaloidal flows, vesicular flows; amphibolite; migmatitic metavolcanics; sulphide iron formation; schist, gneiss.

metamorphism and deformation and may be the mafic intrusive equivalents of the mafic to intermediate volcanic rocks. Felsic intrusive rocks within the metavolcanic assemblages probably are the hypabyssal equivalents of the felsic to intermediate effusive and pyroclastic volcanic rocks though some possibly are related phases of the granitic complexes.

While some phases of the granitic complexes show intrusive relationships to the metavolcanic-metasedimentary sequence, the early granodioritic and trondhjemitic phases of the complexes could possibly represent sialic crust upon which the metavolcanic-metasedimentary sequence formed. No isotopic ages have been determined, as yet, to either confirm or reject this hypothesis.

The Vista Lake, Flindt River, and Vanessa Lake Intrusions appear to represent phases in the development and emplacement of the eastern granitic complex. They have been described separately from the granitic complexes because of their general internal position within the metavolcanic-metasedimentary sequence.

The Sturgeon Narrows and Squaw Lake Alkalic Complexes, which intrude the metavolcanic-metasedimentary sequence, appear to be post-metamorphic and in part post-deformation. Their relationship to the granitic complexes is unknown. The author believes these alkalic complexes are probably Early Precambrian in age.

The volcanic-sedimentary sequence and the gabbro-diorite bodies that intrude it, have been regionally metamorphosed under amphibolite facies conditions adjacent to the granitic complexes and greenschist facies conditions in the internal portion of the belt. Hornblende-hornfels facies metamorphism occurred adjacent to the Vista Lake, Flindt River and Vanessa Lake Intrusions. The presence of both andalusite and apparently retrograded andalusite in pelitic metasediments of assemblage H is suggestive of a complex metamorphic history. Adjacent to both the Sturgeon Narrows and Squaw Lake Alkalic Complexes the volcanic and/or sedimentary rocks have been variably fenitized.

Stratigraphic correlation in the map-area is hindered by complex folding and faulting and by intrusion of the various intrusive complexes into the metavolcanic-metasedimentary sequence. Faulting or at least the development of extensive zones of shearing subparallel to stratigraphic contacts complicates correlation along Sturgeon Narrows and the Northeast Arm of Sturgeon Lake. The Sturgeon Narrows Structural Zone is perhaps the major structural feature in the area and may have been at one time a controlling feature in the evolution of this area as an alkalic magmatic subprovince. Several periods and types of folding have occurred.

Early Precambrian (Archean)

METAVOLCANICS AND METASEDIMENTS

Metavolcanics

Metavolcanics, predominantly flows with lesser pyroclastic and intrusive equivalents, form the bulk of the metavolcanic-metasedimentary sequence. Table 3 illustrates the range in chemical composition. In the field, the metavolcanics were divided into (1) felsic to intermediate (less than 30 percent mafic minerals) and (2) mafic to intermediate (greater than 30 percent mafic minerals). While Table 3 shows that there is an intermediate grouping of metavolcanics on the basis of chemical composition, the recognition of an intermediate subdivision was not generally possible in the field with any precision. Colour index for the fine-grained and aphanitic rocks and mafic mineral percent for the coarser rocks has been substantially modified by intense alteration accompanying deformation, particularly along the Northeast Arm. Alteration, accompanying deformation of the mafic to intermediate metavolcanics has effectively reduced the colour index transforming them to white or brown weathering rocks composed of fine-grained light coloured chlorite and iron carbonate, while the felsic to intermediate metavolcanics have been effectively darkened by the addi

tion of brown-weathering iron carbonate. Alteration effects result in the presence of normative corundum (Table 3) reflecting an excess of alumina for that required to form the normative minerals.

Grab samples for chemical analysis were selected so as to be as free as possible of alteration effects. Samples obtained from pyroclastic units comprise either clasts or homogeneous pyroclastic material. The normative calculations were made following the method outlined by Irvine and Baragar (1971).

MAFIC TO INTERMEDIATE METAVOLCANICS

Mafic to intermediate metavolcanics constitute most of five assemblages (A, D, G, I, and J) in the map-area, as well as forming intercalated units in other assemblages. They range in composition from basalt to andesite to locally dacite and have been metamorphosed under greenschist, amphibolite, and hornblende hornfels facies conditions (as defined by Turner 1968). These rocks vary from massive to well foliated to locally cataclastic or fluxion structured.

On weathered surfaces, mafic to intermediate metavolcanics metamorphosed under greenschist facies conditions are light green, grey-green, to locally brown or even white where they have been extensively carbonatized. Their greenschist facies metamorphic mineral assemblages comprise the following minerals: plagioclase (albite-oligoclase) ± quartz ± amphibole ± chlorite ± epidote ± carbonate ± chloritoid plus accessories including opaque oxides, pyrite, pyrrhotite, chalcopyrite, apatite, and sphene. The amphibole is of the tremolite-actinolite series. Quartz occurs interstitially, generally constituting less than 5 percent of a particular unit; chlorite occurs most commonly in the well foliated or schistose units.

Subophitic to ophitic, and rarely isogranular, primary volcanic textures are locally preserved by pseudomorphic recrystallization.

Massive Flows

Both fine-grained and medium-grained flows comprise most of the mafic to intermediate metavolcanic assemblages. The medium-grained rocks may represent the central portions of thick flows; they are particularly common in assemblage A. Some of these medium-grained units may be intrusive equivalents rather than flows. The flows comprising assemblage D, where not pillowed, are fine-grained and relatively thin, on the order of 10 to 25 m thick, often with amygdaloidal or autoclastic breccia flow tops. The flows are variable from weakly foliated to schistose or phyllitic. Where shearing has been intense they have been transformed into light weathering, very fine grained carbonate-chlorite schists.

The flows intercalated in the felsic to intermediate pyroclastic assemblages are commonly fine-grained and range in thickness from less than 0.3 m to, more commonly, several metres thick. Locally these flow units have an apparent intrusive relationship to the felsic to intermediate rocks, showing chilled locally vesicular contacts on both sides. Intrusion may have occurred while the pyroclastic rocks were as yet unconsolidated, involving some sort of plastic injection mechanism.

Porphyritic Flows

Porphyritic flows or porphyritic zones within flows, although uncommon, were locally observed. The phenocrysts are plagioclase end vary in size from 1 to 20-30 mm. Porphyritic pillowed flows were observed in the lower part of assemblage A east of the North Arm of Sturgeon Lake (Photo 1). At least two porphyritic pillowed flows are present and can be traced over a strike distance in excess of 1000 m, and thus are useful marker horizons.

TABLE 3. MAJOR AND TRACE ELEMENT ANALYSES AND NORMATIVE MINERALOGY OF METAVOLCANICS IN THE SQUAW LAKE – STURGEON LAKE AREA.

Major Elements	1[1]	2[1]	3	4	5	6	7	8	9	10	11	12	13	14	15
SiO_2	50.91	50.08	53.70	58.30	62.00	65.80	67.20	67.60	68.30	68.60	69.50	70.00	72.9	73.00	75.40
Al_2O_3	15.17	14.87	16.40	15.10	18.80	15.10	18.80	14.60	15.80	15.10	5.40	16.70	13.8	13.80	14.30
Fe_2O_3	13.01*	12.72*	0.93	0.69	.33	1.33	0.34	1.75	1.20	0.66	0.94	0.36	0.52	0.36	0.54
FeO			8.52	4.65	3.00	3.09	0.81	2.03	3.81	2.28	7.15	1.05	1.62	1.95	4.72
MgO	5.71	7.70	1.65	3.60	1.24	1.57	0.79	0.33	0.63	1.20	3.70	0.63	0.18	0.64	0.19
CaO	10.70	11.81	6.79	5.71	4.01	3.01	2.89	2.95	3.00	2.68	4.14	3.08	1.14	2.58	0.23
Na_2O			1.56	3.43	5.53	3.00	3.40	4.58	0.96	3.32	0.11	2.67	6.75	3.53	0.38
K_2O			0.58	1.01	1.57	2.51	3.47	1.49	1.54	2.18	0.07	2.56	0.58	1.88	1.25
TiO_2			1.49	0.75	0.80	0.47	0.26	0.61	0.34	0.36	1.33	0.28	0.22	0.33	0.31
P_2O_5			0.11	0.14	0.06	0.06	0.07	0.19	0.08	0.07	0.12	0.07	0.05	0.07	0.06
S			.80	.00	0.02	0.13	0.02	0.12	0.01	0.00	0.02	0.11	0.03	0.01	0.00
MnO			.22	.07	0.07	0.04	0.03	0.04	0.09	0.04	0.14	0.03	0.01	0.10	0.07
CO_2			4.30	3.22	0.75	2.23	1.65	2.35	2.12	2.28	5.71	1.08	0.99	0.55	0.69
H_2O^+			4.27	2.17	0.75	2.31	1.84	1.59	2.29	2.06	1.56	1.41	0.61	0.91	1.22
H_2O^-			0.05	0.09	0.01	0.05	0.03	0.34	0.03	0.06	0.08	0.01	0.16	0.00	0.04
Total			101.40	98.90	98.90	100.10	101.06	100.60	99.70	100.90	100.00	100.00	98.60	99.70	99.40
Specific Gravity	nd	nd	2.78	2.81	2.66	2.71	2.67	2.70	2.80	2.69	2.75	2.69	2.60	nd	2.73

CONTINUED

TABLE 3. CONTINUED.

Trace Elements	1[1]	2[1]	3	4	5	6	7	8	9	10	11	12	13	14	15
Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
As				60		3				7	4				<3
Ba	50	60	160	160	300	1000	410	340	450	470	<150	290	80	200	200
Be	<1	<1	<1	<3	<1	<3	<1	<1	<1	<3	<3	<1	<1	<1	<3
Co	65	50	60	25	35	25	<5	8	8	6	10	<5	<5	5	7
Cr	320	170	130	10	230	260	<5	<5	15	<10	2500	<5	<5	20	<10
Cu	100	20	190	45	70	45	6	8	<5	20	130	10	10	20	8
Ga	20	10	10	20	10	30	20	10	20	10	25	20	20	20	20
Li	10	15	30	15	25	20	9	10	8	10	30	6	3	10	2
Mo	<1	<1	<1	<10	<1	<10	<1	<1	<1	<10	10	<1	<1	<1	<10
Ni	150	70	100	55	110	260	9	5	15	30	440	9	<5	10	20
Pb	15	15	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Sc	40	40	150	<20	20	<20	<10	<10	10	<20	<20	<10	<10	<10	<20
Sn	<1	<1	<1	<10	<1	<10	<1	<1	<1	<10	40	3	3	<1	<10
Sr	75	50	100	30	400	100	100	300	100	100	10	200	200	100	15
V	350	250	200	130	100	70	30	20	20	50	180	20	10	40	160
Y	30	20	40	<20	10	<20	<10	<10	<10	<20	<20	<10	<10	<10	<20
Zn	110	90	170	80	70	60	35	180	35	60	150	50	120	50	50
Zr	60	70	100	140	30	60	50	100	30	110	40	70	70	50	60

SAMPLES

	Sample No.	Latitude	Longitude	Lithology
1	1-8-7C-2	50.09100	90.72000	Mafic flow
2	1-17-6A	50.08300	90.71000	Mafic flow
3	T850-1	50.07500	90.6000	Intermediate to mafic flow
4	1-26-12C-1	50.02588	90.69588	Intermediate to mafic flow
5	T349-1	50.09167	90.58333	Intermediate tuff
6	1-37-8B-2	50.06520	90.63750	Intermediate tuff-breccia
7	T4515-1	50.1333	90.61667	Felsic to intermediate tuff
8	T657-1	50.07500	90.50833	Felsic to intermediate tuff/flow
9	1-64-2A-1	50.11667	90.60000	Felsic to intermediate tuff/porphyry
10	1-58-6A-1	50.09160	90.64860	Felsic to intermediate tuff/flow
11	1-43-13B-3	50.07250	90.63800	Felsic to intermediate flow breccia
12	T8016-1	50.12500	90.54167	Felsic to intermediate tuff
13	T4299-1	50.10694	90.62917	Felsic tuff
14	T4581-2	50.13333	90.56667	Felsic tuff
15	1-45-1B-2	50.05830	90.64360	Felsic tuff

CONTINUED

TABLE 3. CONTINUED.

Normative Minerals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Quartz			21.967	15.041	11.024	29.725	25.131	27.718	50.837	31.231	54.210	35.541	26.200	36.032	64.343
Corundum			1.363		0.948	3.113	4.854	0.623	9.713	2.943		4.649	0.129	1.617	14.225
Orthoclase			3.806	6.407	9.410	15.063	20.923	9.225	9.990	13.509	0.474	15.716	3.478	11.484	7.997
Albite			15.549	33.027	50.316	27.344	31.119	43.046	4.530	31.231	1.130	24.861	61.437	32.732	3.690
Anorthite			36.605	24.482	19.767	14.749	14.152	14.022	15.752	2.943	16.055	15.388	5.403	12.749	0.810
Diopside				2.488							2.651				
Hedenbergite				1.449							2.383				
Enstatite			5.057	9.415	3.469	4 394	2.223	0.954	1.908	3.471	10.257	1.805	0.504	1.825	0.567
Ferrosilite			8.929	5.483	3.388	2.815	0.646	0.755	5.154	2.759	8.571	0.676	1.776	2.512	7.154
Magnetite			1.079		0.350	1.476	0.362	1.915	1.376	0.723	1.124	0.391	0.551	0.389	0.611
Ilmenite			2.304	1.121	1.129	0.665	0.367	0.890	0.519	0.525	2.119	0.405	0.311	0.475	0.467
Pyrrhotite			3.084	0.774	0.070	0.479	0.071	0.436	0.038	0.000	0.079	0.396	0.106	0.036	0.000
Apatite			0.276	0.314	0.127	0.133	0.149	0.416	0.184	0.154	0.267	0.152	0.106	0.151	0.136
Normative Plagioclase			$An_{70.19}$	$An_{42.57}$	$An_{28.21}$	$An_{35.04}$	$An_{31.26}$	$An_{24.57}$	$An_{77.67}$	$An_{30.11}$	$An_{93.43}$	$An_{38.21}$	$An_{8.06}$	$An_{28.03}$	$An_{17.99}$
Normative Colour Index[2]			17.37	20.73	8.34	9.35	3.60	4.51	8.96	7.48	27.31	3.28	3.14	5.20	8.80
Differentiation Index[3]			41.32	54.47	70.75	72.13	77.17	79.99	65.36	75.97	55.81	76.63	91.11	80.25	76.03

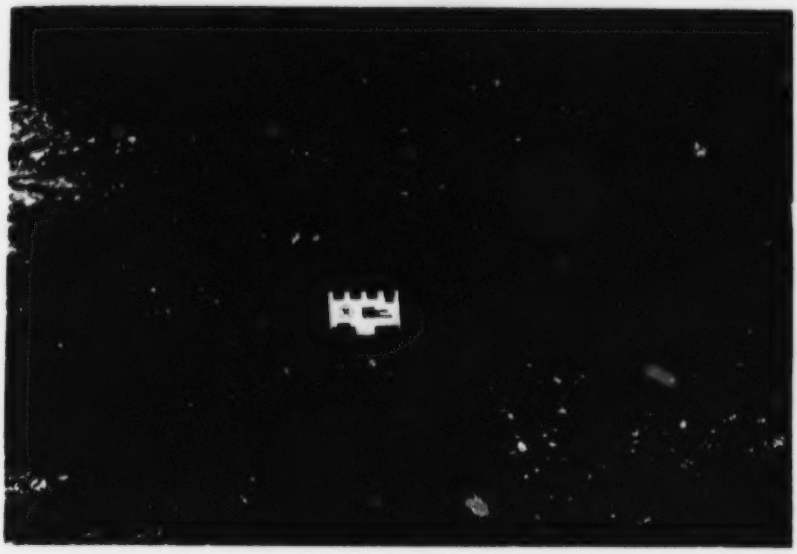
NOTES

[1]Partial chemical analysis.

[2]Normative colour index = sum of normative diopside, hedenbergite, enstatite, ferrosilite, forsterite, fayalite, magnetite, ilmenite.

[3]Differentiation index = sum of normative quartz, orthoclase, albite.

Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto. Major element analyses in weight percent; trace element analyses in parts per million; normative compositions in molecular weight percent. Analytical methods: X-ray fluorescence – SiO_2, Al_2O_3, Fe_2O_3, MgO, CaO, TiO_2, MnO, chemical methods – FeO, Na_2O, K_2O, P_2O_5, S, CO_2, H_2O.



OGS 10521

Photo 1. *Porphyritic pillowed lava from lower mafic to intermediate metavolcanic assemblage A. Phenocrysts are of subhedral, subrounded, plagioclase (oligoclase) which vary in size from 2-3 to 25 mm. Phenocrysts are primarily confined to pillow interiors.*

Flows containing subhedral to anhedral plagioclase phenocrysts occur along the east shore of Vanessa Lake. Here, however, it is uncertain whether they are porphyroblasts or cognate phenocrysts.

Pillowed Flows

Pillowed flows and flow units occur within all the mafic to intermediate metavolcanic assemblages within the map-area.

In the west at the bottom of assemblage A, the lower mafic to intermediate metavolcanic assemblage pillows are large, 2.4 by 1.2 m to 6.1 by 1.8 m, mattress-shaped, and generally non-amygdaloidal. Both eastward and northwards the pillows become smaller, more bun-shaped, and distinctly amygdaloidal. In the area west of the upper portion of Couture Lake the pillows appear attenuated with length to width ratios of 4:1 to 12:1. Locally the selvages comprise upwards of 40 percent of the pillowed unit and the pillows themselves have a bulbous shape (Photo 2). In other outcrops in this location the pillow selvages average 1.5 to 5 cm in width and are highly contorted (Photo 3). The pillows along the Northeast Arm (Photo 4) are small, 0.2 by 0.1 m to 0.9 by 0.3 m and coarsely vesicular or amygdaloidal suggesting shallow water emplacement. They are locally pseudomorphically replaced by iron carbonate. Pillow breccia units (see below) are associated with these pillowed units. In the area west and south of Squaw Lake, large vesicular pillows are up to 6 m long, and the vesicles or gas cavities locally have lengths of 0.15 m. In the eastern amphibolite zone (assemblage J) some of the banded structure of the amphibolites was apparently formed by the stretching out of individual pillows whereby the selvages

OGS 10522

Photo 2. *Ball shaped pillow masses from lower mafic to intermediate metavolcanic assemblage A. Material between pillows comprises thick selvages and perhaps fine interpillow sedimentary debris although if the fine-grained material is flow material these structures may be lava tubes.*

OGS 10523

Photo 3. *Pillowed mafic to intermediate metavolcanic flow from lower mafic to intermediate metavolcanic assemblage A showing highly contorted pillow selvages. Contortion of selvages may have occurred while pillows were still plastic or could be a result of later deformation.*

OGS 10524

Photo 4. *Typical highly vesicular (amygdules weathered out) pillowed flow from mafic to intermediate metavolcanic assemblage along and east of Northeast Arm of Sturgeon Lake. Vesicules are up to 3 cm in diameter. Pillows weather brown-red and are highly carbonatized.*

and interior portion of the pillows now define contrasting colour bands. Pillows form both tholeiitic and calc-alkalic flows.

Hyaloclastite (Pillow Breccia) Units

A few hyaloclastite units were recognized within the predominantly mafic to intermediate metavolcanic assemblage D along the east shore of the Northeast Arm of Sturgeon Lake. They occur as narrow (3 to 6 m wide) discontinuous (9 to 21 m long) zones generally associated with, or subunits of, amygdaloidal pillowed flows. These units were only recognized with certainty along the shoreline, but this is probably because outcrops eroded by wave action reveal their internal fragmental features better than inland outcrops. Also the units observed were only weakly foliated and major shearing could have obliterated the characteristic features of these units elsewhere.

On the west shoreline of Nipigon Bay both isolated and broken pillow breccia (Carlisle 1963) were recognized. Isolated pillow breccia in which unbroken amoeboid shaped lava masses (pillows) are suspended in a matrix of lapilli-tuff-sized shards and intershard mesostasis, is transitional along strike through a zone composed of a mixture of isolated and broken pillow breccia (Photo 5) to broken pillow breccia. The broken pillow breccia comprises three components. Pillow fragments dominate, and lapilli-tuff-sized shards and intershard matrix are present in minor amounts. The fine shards produced by granulation of the original lava globules have retained their original shape, though subsequent devitrification and metamorphism have transformed the shards and the intershard matrix to chlorite-carbonate pseudomorphic aggregates. In outcrop the shards and matrix weather a pale yellow colour.

OGS 10525

Photo 5. *Transitional phase of isolated pillow breccia with major interpillow matrix (left) through to broken pillow breccia with subordinate interfragment matrix (right). From west shoreline, Nipigon Bay.*

Thin units of broken pillow breccia (Photo 6) were seen in the mafic to intermediate metavolcanic assemblage D on the shoreline east of Morgan Island. The fine shards and their matrix are now represented by the chlorite-carbonate aggregates in which the pillow fragments are set. Locally small unfractured globules or small pillows are present.

If more exposures of these hyaloclastite units were available they would, no doubt, make excellent marker horizons. As it is, however, they can possibly be used as palaeoenvironment indicators. Their association with amygdaloidal pillow lava flows and intense fragmentation indicates that they may be a shallow water facies of hyaloclastites (Furnes 1972, p.400).

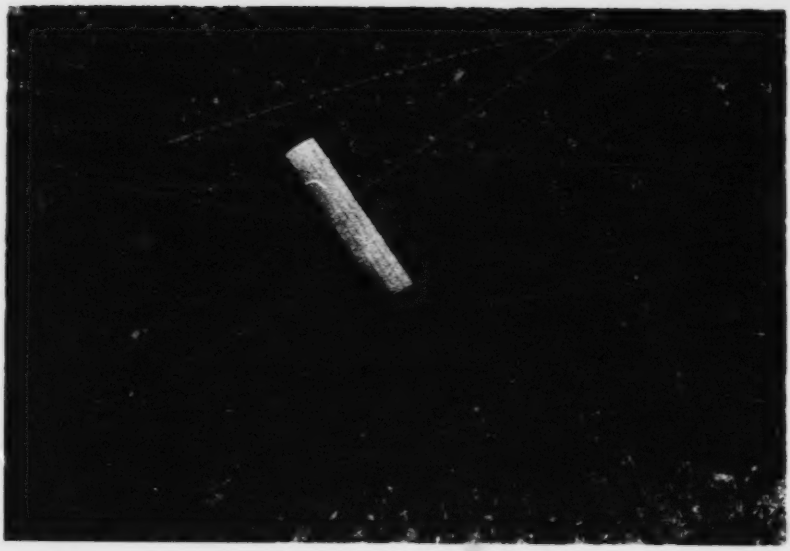
Autoclastic Breccia, Vesicular and Amygdaloidal Flows

Autoclastic flow breccia, comprising subangular mafic to intermediate fragments set in a matrix of similar composition, locally comprises the upper metre or so of a volcanic flow (flow-top breccia).

Vesicular and amygdaloidal flows are common particularly in mafic to intermediate metavolcanic assemblages D and G. The pillowed units within these assemblages locally contain concentrations of vesicles or amygdules towards the top of individual pillows. Anomalously large elliptical shaped vesicles or gas cavities up to 20 by 10 cm in dimension occur within very large pillows from assemblage G. The amygdular filling is composed of carbonate and/or quartz.

Pyroclastic Rocks

Mafic to intermediate pyroclastic rocks comprise only a small portion (less than 5 percent)



OGS 10526

Photo 6. *Broken pillow breccia hyaloclastite unit from shoreline of Northeast Arm of Sturgeon Lake east of Morgan Island. Three types of fragments are present; they are, in decreasing order of abundance: fragments comprising both a portion of internal vesicular pillow and outer selvage material, fragments composed only of internal vesicular pillow material, and fragments composed only of selvage material.*

of the mafic to intermediate metavolcanic assemblages within the map-area. They occur as thin interflow units between the mafic to intermediate flows. They vary from less than 1 m to several metres to rarely approximately 30 m in thickness. They show their greatest development in the area on and around the upper portion of Couture Lake and of Ouilette Lake. Here they are primarily associated with mafic, predominantly pillowed flows. They are predominantly lithic-crystal ash tuff with minor lapilli-tuff and rare tuff-breccia. Four partial chemical analyses (by Geoscience Laboratories, Ontario Geological Survey) of four grab samples collected by the field party from these units showed silica contents ranging from 46 to 68 percent, and covering the span from mafic to intermediate volcanic rocks. Mafic mineral content varies from 20 to 40 percent and includes both chlorite and actinolite. Crystal grains or fragments comprise medium-grained, subangular plagioclase and quartz. The quartz grains vary in colour from grey to a distinctive light blue. The clasts are generally 3 to 8 cm in diameter and elliptical in shape. The clasts are predominantly intermediate to locally felsic metavolcanics. Fine-grained mafic vesicular bombs occur locally. The local presence of banded clasts of apparent intermediate tuff suggests that these units have been derived from partially reworked pyroclastic debris or were ripped off the volcanic vent during subsequent eruptions. Bedding is locally developed.

Amphibolite

Amphibolites of predominantly volcanic origin, though possibly including mafic intrusive equivalents, are found adjacent to the granitic complexes. The zone of amphibolite facies

metamorphism is continuous and much wider along the eastern margin of the metavolcanic-metasedimentary belt than along the western margin where it is only intermittently developed. It may be that the eastern granitic complex dips under the metavolcanic-metasedimentary belt at a shallower angle than does the western granitic complex.

On the weathered surface the amphibolitic rocks are grey-green to dark-green to locally black, while on the fresh surface they are dark green to black. Their mineral assemblage comprises plagioclase (oligoclase-andesine) + quartz + hornblende ± biotite ± garnet ± epidote ± clinopyroxene ± carbonate + accessories including pyrite, pyrrhotite, magnetite, sphene, and apatite. The amphibole is dark green to blue-green hornblende, while biotite is pleochroic in shades of light brown to red-brown. Light red garnet porphyroblasts occur locally, commonly forming glomeroporphyroblastic lensoid aggregates, surrounded by a hornblende-rich rim. Plagioclase feldspar phenocrysts or porphyroblasts are locally present. They are apparently pre-tectonic (phenocrysts) as the subparallel hornblende and biotite grains bend around them. Primary volcanic textures are obscured and only recognition of such features as pillows and amygdules make certain a volcanic origin for these rocks.

The amphibolites occur in three main fabric types:

1. Well foliated to layered amphibolite consists of alternating feldspathic- and mafic-rich bands defining a compositional layering. Locally pillows 3.8 cm wide and up to 76 cm long were observed. The layering varies from continuous to discontinuous to lenticular. The thickness of the individual layers varies from 2 mm to 2 cm. More complex layering is observed in thin section and involves the relative distribution of such minerals as biotite, garnet, epidote and clinopyroxene.
2. Massive equigranular amphibolite consists of subhedral, approximately equant plagioclase and hornblende grains, intergrown in an unoriented decussate texture. This fabric may have formed by recrystallization of original medium-grained, massive mafic intrusive equivalents or of medium-grained central flow portions.
3. Porphyroblastic amphibolite consists of medium- to coarse-grained hornblende laths, set in a fine-grained matrix. Two main growth forms are evident: (a) hornblende needles, which are highly elongated and subparallel, defining a lineation but not a foliation, and (b) hornblende rosettes forming rosette-shaped aggregates of hornblende laths. Porphyroblastic hornblende growth appears to have occurred in original fine-grained volcanic rocks and was specifically noted in pillowed, porphyritic, and amygdaloidal flows.

Boudinage structure, defining a lineation, was observed in several scattered localities. Commonly it consists of feldspathic boudins set in mafic-rich layers, garnets being preferentially developed in the boudins. The necks between the boudins are commonly filled with quartz.

Carbonate blobs and lensoid aggregates up to 10 cm in length are locally present and may have formed by metamorphic segregation.

FELSIC TO INTERMEDIATE METAVOLCANICS

Felsic to intermediate metavolcanics are composed predominantly of dacitic, rhyodacitic, and minor rhyolitic pyroclastic rocks, metamorphosed under low (chlorite subfacies) to medium (chlorite biotite subfacies) greenschist facies conditions. They form two major assemblages (B and E), and several thin members (assemblage F) intercalated in mafic to intermediate assemblage D. Both major assemblages contain thin intercalated mafic to intermediate metavolcanic flows and are extensively intruded by gabbro and diorite sills, dikes, and irregular masses.

The mineral assemblages of the felsic to intermediate metavolcanics are: (1) (lower greenschist facies) quartz + albite + muscovite ± microcline ± chlorite ± chloritoid ±

stilpnomelane ± actinolite; and (2) (medium greenschist facies) quartz + albite + muscovite ± microcline ± biotite ± chlorite ± chloritoid ± actinolite. Accessories include carbonate (calcite and ferroan dolomite), epidote, iron-titanium oxide (locally containing substantial Cr, see Table 3, sample 1-43-13B-3), tourmaline, zircon, pyrite, pyrrhotite, hematite and talc.

Chloritoid and stilpnomelane were found within a restricted zone (see chloritoid occurrences on Map 2420, back pocket) approximately 12 000 m long and 750 m wide, that begins at the south end of Morgan Island and extends almost to the top of the Northeast Arm. Stilpnomelane is a major mineral in the carbonate breccia map-unit (see below) while a few fine grains were found in the felsic metavolcanics which lie in close proximity to it. Stilpnomelane may have formed from clay minerals during diagenesis, or low-grade metamorphism (French 1973). Chloritoid metacrysts were found in the felsic to intermediate metavolcanics within this zone (chloritoid was also uncommonly found in mafic to intermediate metavolcanics). Chloritoid is not uniformly developed but rather is confined to specific lithological units within this zone. Chloritoid was also found in felsic metavolcanic inclusions within the mixed breccia subunit of the carbonate breccia map-unit.

Chloritoid occurs as poikiloblasts which appear to be randomly oriented with respect to the penetrative foliation. The grains are subhedral to euhedral, polysynthetically twinned, and occur as single grains or in rosette aggregates. They are generally 1 to 2 mm long though rosette aggregates may reach 3 to 4 mm in diameter. In hand specimen they are dark green to black while in thin section they are pleochroic in colours of pale green to green. They are characteristically polysynthetically twinned. Individual grains generally have slightly corroded borders. They appear to show a preferential development in the more highly sheared rocks. A similar occurrence of chloritoid in felsic to intermediate metavolcanics was noted in the southern portion of Sturgeon Lake (Trowell 1974a), where chloritoid is present both in minor amounts in the lowermost felsic to intermediate pyroclastic assemblage and in substantial amounts within, and in part defining, the footwall alteration zone of the Mattabi Mines Limited base metal sulphide orebody (Franklin *et al.* 1975).

Other mafic minerals in the felsic to intermediate metavolcanics include chlorite, minor to major biotite, and rare actinolite. Biotite begins to appear, in assemblage B, near the end of the Northeast Arm, indicative of increasing metamorphic grade to the north.

Most of the felsic to intermediate metavolcanics are pyroclastic rocks. Only a few flow units were tentatively identified, primarily on the basis of finely banded and contorted internal structures that could represent primary flow banding. The spherulitic units have been tentatively interpreted as tuffs though they could be flows. Felsite units could be either flows, ash tuffs, or intrusions.

Pyroclastic Rocks

While Fisher's (1966) classification of pyroclastic rocks has been roughly followed with respect to the size classification, the author has placed greater emphasis on the largest clast size present irrespective of the overall abundance of this size fraction. The largest size fraction is more closely related to a specific volcanic event, whereas the fine ash fraction may represent a combination of deposits such as airfall material from a distant source, settling of background ash suspensions in the volcanic-sedimentary basin, and reworked ash material.

On the weathered surface these rocks are light grey, light green, white, pink and locally brown due to iron carbonate alteration, while on the fresh surface they are grey, light green, pink, dark grey to almost black. The pyroclastic units that border the northern portion of the Squaw Lake Alkalic Complex are weakly fenitized, and show either pink (feldspathization) or green (chloritization) colour on the weathered surface. It was also in this area that jarosite (X-ray determination by Geoscience Laboratories of sample collected by

field party), a potassium sulphate, yellow in colour, occurs as finely disseminated grains in one outcrop of felsic to intermediate pyroclastic rocks.

The pyroclastic rocks are dominantly coarse ash tuff to fine lapilli-tuff with local substantial accumulations of lapillistone to tuff-breccia (Photo 7), and pyroclastic breccia. The thickness of these units is highly variable from less than 1 m to over 100 m. The maximum thickness of assemblage B measured in the Morgan Island area is 2400 m although portions could be repeated by folding. South of Morgan Island it thins over a short distance to less than 300 m and is comprised predominantly of ash tuff with local lapilli-sized clasts. Farther to the southwest it appears to be continuous with the dacitic to rhyodacitic assemblage of the Six Mile Lake area (see Trowell 1976). To the northeast, assemblage B thins gradually although gabbro and diorite bodies increase in abundance. Assemblage E is 600 m thick north of Coveney Island. To the northeast, assemblage E appreciably thins until it becomes indistinguishable from the several thin members (assemblage F) intercalated in mafic to intermediate metavolcanic and intrusive rocks of assemblage D. The Morgan Island area where the thickest accumulation of assemblage B is located may be the site of an original volcanic centre.

The pyroclastic rocks are essentially monolithic although intense cataclasis, especially along Northeast Arm, masks the composition of the finer clasts. Felsic volcanic clasts predominate, with local minor intermediate feldspar porphyry, cherty, and blocky banded (bedded) ash tuff clasts. Irregular mafic blobs may be spatter or scoria derived from concomitant mafic volcanic activity. The larger clasts are dominantly felsic or felsic to intermediate in composition, generally porphyritic or fine-grained and vary in shape from blocky angular to subangular to subrounded to locally round, ellipsoidal, or rounded spindle-shaped. The clasts weather colours similar to the outcrop as a whole. Locally the weathered surface has a pock-marked or potholed appearance presumably due to the weathering out of large clasts. Clast size varies from 1 by 1 mm to 1.2 by 0.6 m, the very large clasts having a blocky-angular shape.

The tuff fraction of the pyroclastic rocks varies from lithic-crystal to crystal to locally lithic in composition. Angular to subrounded, locally broken, quartz, and feldspar and rare microcline crystals and crystal fragments comprise an appreciable proportion of these units. Quartz crystals, which locally have a slight bluish tinge vary in size from less than 1 to approximately 15 mm, they average 2 to 3 mm and comprise from 0 to 10 percent of these rocks occurring both as discrete crystals and crystal fragments and as phenocrysts within the porphyritic clasts. Feldspar crystals average 1 to 6 mm in length and have a distribution similar to the quartz crystals. Recrystallization has destroyed the primary textures but where deformation is slight, primary textures such as lobate amoeboid quartz crystals and corroded, zoned plagioclase crystals are preserved. A few clasts have a frothy vesicular appearance which may reflect an original pumiceous origin.

The roundness of the clasts, specifically in assemblage B appears to increase both eastwards and northeastwards. The clasts are lensoid or spindle-shaped with dimensional ratios of 5:2:1. The intermediate axis is parallel to strike and the long axis is down dip. Their shape could reflect either primary volcanic origin, subsequent reworking, or deformation. It should be noted that their long axis is uniformly oriented down dip, generally lying along the linear intersection of two schistosities. Locally some clasts have an elongated rhombic or diamond shape (horizontal surface) with their opposite sides paralleling the two schistosity trends.

The association of coarsely amygdaloidal, and pillowed, mafic to intermediate volcanic flows, pillow breccias, and local volcanogenic sedimentary units with the felsic to intermediate pyroclastic rocks of assemblage B, suggests that the pyroclastic rocks were deposited primarily in a subaqueous environment. The presence of thin volcanogenic sedimentary layers in the Morgan Island area and the sedimentary features of the rock units to the northeast would suggest that the pyroclastics were reworked and redeposited likely by subaqueous pyroclastic flows (Fiske 1963). Assemblages E and F are predominantly py-

OGS 10527

Photo 7. *Felsic to intermediate lapillistone to tuff-breccia from Northeast Arm area, Sturgeon Lake. Photos illustrate various sizes of clasts, percentages of clast sizes present and various clast shapes. Left photo illustrates slightly polymictic composition of clasts and an uneven distribution while centre photo and right photo show oligomictic composition of clasts. Right photo especially illustrates similarity between large clasts and ash tuff (crystal) matrix making it difficult in some cases to actually identify these units as fragmental.*

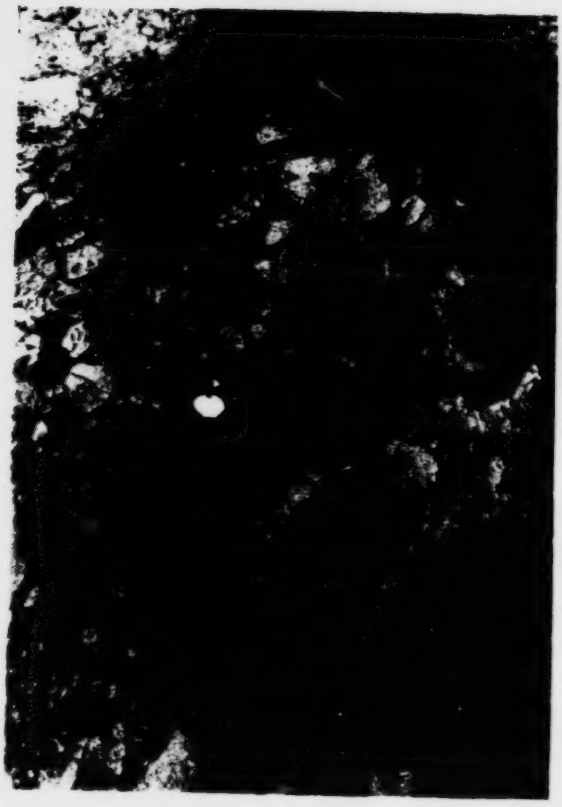
roclastic though to the east and north individual units of assemblage F are more sedimentary in nature, suggestive of subaqueous deposition of reworked pyroclastic debris. Thin units of ferruginous volcanogenic wacke are present on the east shore of Michell Lake. In some of these units as well as in some of the ash tuff units of assemblage B that outcrop near the north end of the Northeast Arm, fine grains of magnetite (detrital origin?) form thin discontinuous laminae. The pyroclastic units of assemblages E and F generally lie in the tuff to lapilli-tuff size range. Larger fragment sizes are only locally present as for instance on the upper portion of Coveney Lake.

Cataclasis has locally transformed the felsic to intermediate pyroclastic rocks into quartz + albite + muscovite + carbonate ± chlorite ± chloritoid schist, phyllite, fluxion structured mylonite, and blastomylonite. Photo 8 illustrates a mylonitic texture showing both fluxion structure and deformation banding in quartz porphyroclasts. The quartz porphyroclasts have recrystallized but locally have retained their original exterior lobate, corroded to amoeboid volcanic forms. They now show undulose extinction and the development of deformation lamellae at an angle to the fluxion structure.

Mode of Deposition. Several units within the northern portion of assemblage B were possibly deposited by subaqueous pyroclastic flows. Three types of units were found: (1) thick (3 to 75 m), locally size-graded accumulations of both monolithic and heterolithic lapillistone and tuff-breccia (Photo 9); (2) graded units of lapilli-tuff 3 to 15 m thick; and (3) graded, fine-ash tuff in finely laminated units up to 0.6 m thick, and in bedded units up to 4.5 m thick, with individual beds 8 to 30 cm thick. Field relationships (Figures 3a,b,c,d) between these units are revealed in several areas of almost continuous outcrop exposed over

OGS 10528

Photo 8. *Photomicrograph of cataclastic felsic ash tuff (phyllite) from island in Northeast Arm of Sturgeon Lake. Quartz grain (dark grey) in upper portion of photo shows deformation lamellae at an angle to fluxion structured foliation defined by parallel alignment of mineral grains in lower portion of photo. Crossed nicols, 12X.*



OGS 10529

Photo 9. *Mixed felsic to intermediate tuff-breccia from west shore of upper portion of Northeast Arm of Sturgeon Lake. Fragments, which are subangular to subrounded, include felsic volcanic clasts (white, light grey), mafic to intermediate volcanic, locally vesicular clasts (medium to dark grey), mafic volcanic clasts or spatter (dark grey to black), and banded (bedded) tuffaceous clasts (to top of compass). The rock may represent a subaqueous pyroclastic flow.*

several metres to more than 100 m. Figure 3a illustrates what the author would suggest is one complete subaqueous pyroclastic flow unit: a lower lapillistone and tuff-breccia unit, transitional over slightly more than 1 m to graded lapilli-tuff, which in turn is sharply overlain by a lower finely laminated unit and an upper thicker-bedded unit of fine to coarse ash tuff. The sequence is approximately 106 m thick. Figures 3b, c, d show partial sequences or details of the units that comprise a particular portion of a sequence.

Sedimentary structures other than graded bedding include local fine-scale cross-bedding in fine tuff beds, and local slump and scour structures in fine tuff and coarse tuff to

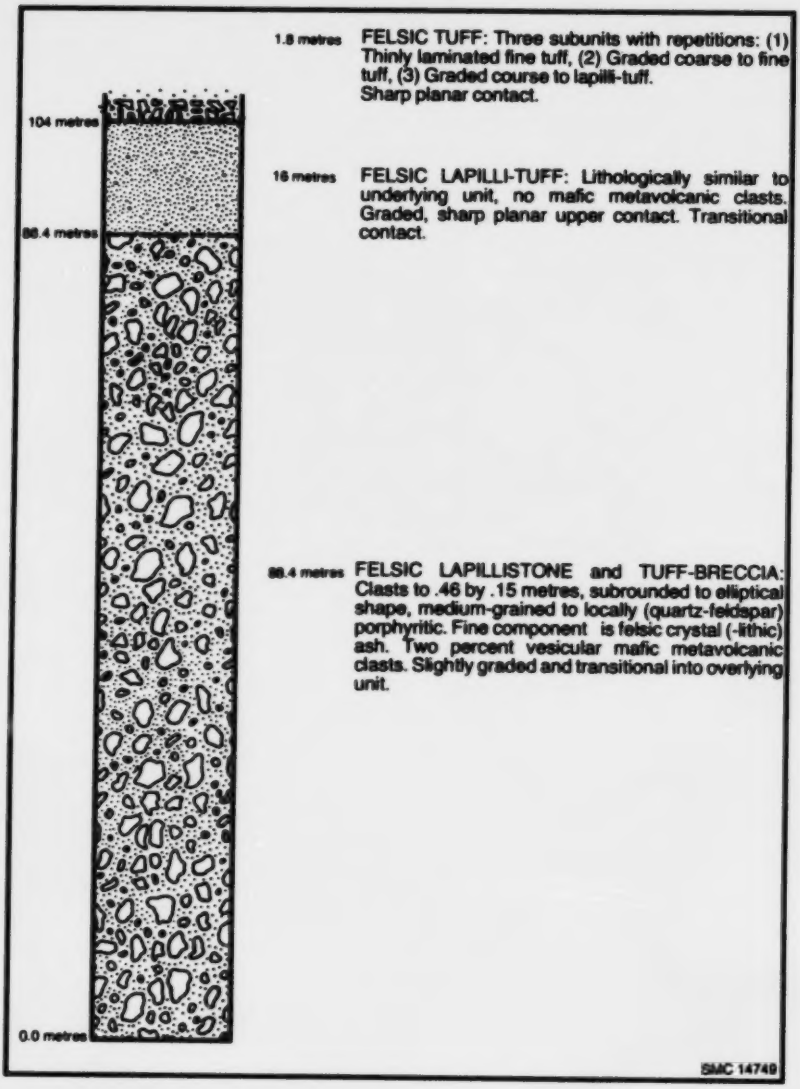

104 metres
88.4 metres
0.0 metres
1.8 metres
FELSIC TUFF: Three subunits with repetitions: (1) Thinly laminated fine tuff, (2) Graded coarse to fine tuff, (3) Graded course to lapilli-tuff. Sharp planar contact.
16 metres
FELSIC LAPILLI-TUFF: Lithologically similar to underlying unit, no mafic metavolcanic clasts. Graded, sharp planar upper contact. Transitional contact.
88.4 metres
FELSIC LAPILLISTONE and TUFF-BRECCIA: Clasts to .46 by .15 metres, subrounded to elliptical shape, medium-grained to locally (quartz-feldspar) porphyritic. Fine component is felsic crystal (-lithic) ash. Two percent vesicular mafic metavolcanic clasts. Slightly graded and transitional into overlying unit.
SMC 14749

Figure 3. *Detailed sections of subaqueous pyroclastic flow, Northeast Arm of Sturgeon Lake.* ***a.*** *106 m exposure of subaqueous pyroclastic flow, Northeast Arm of Sturgeon Lake.*

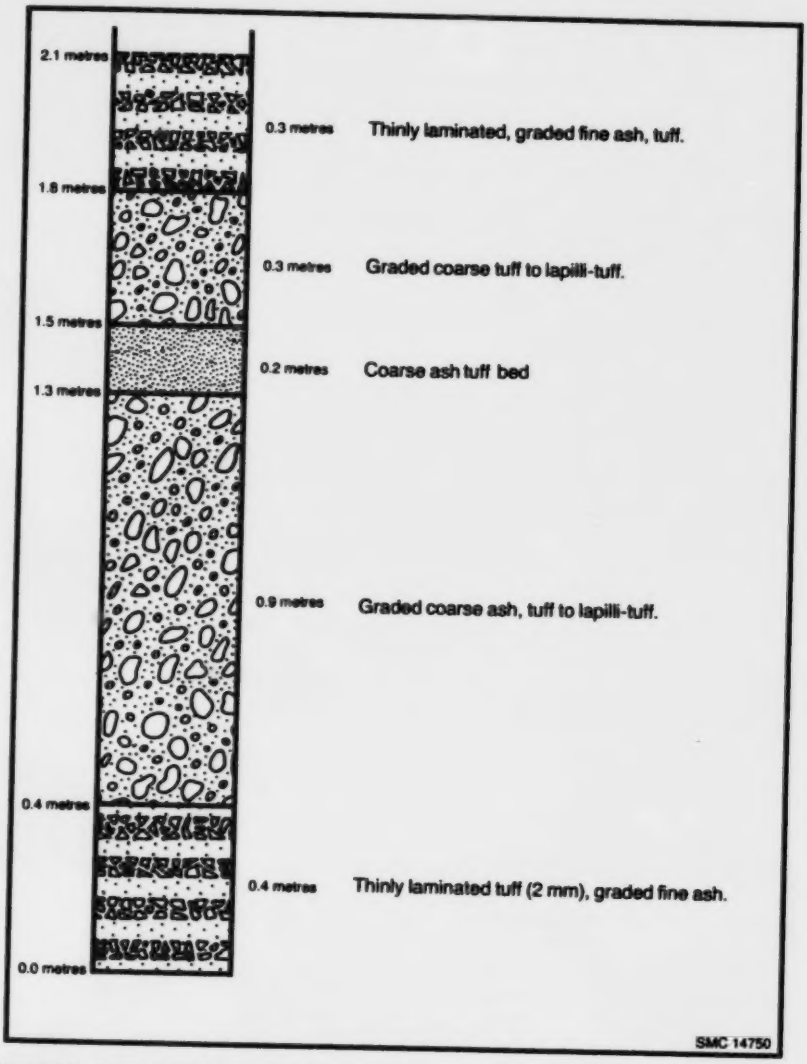


Figure 3b. *Detail of felsic tuff unit of Figure 3a.*

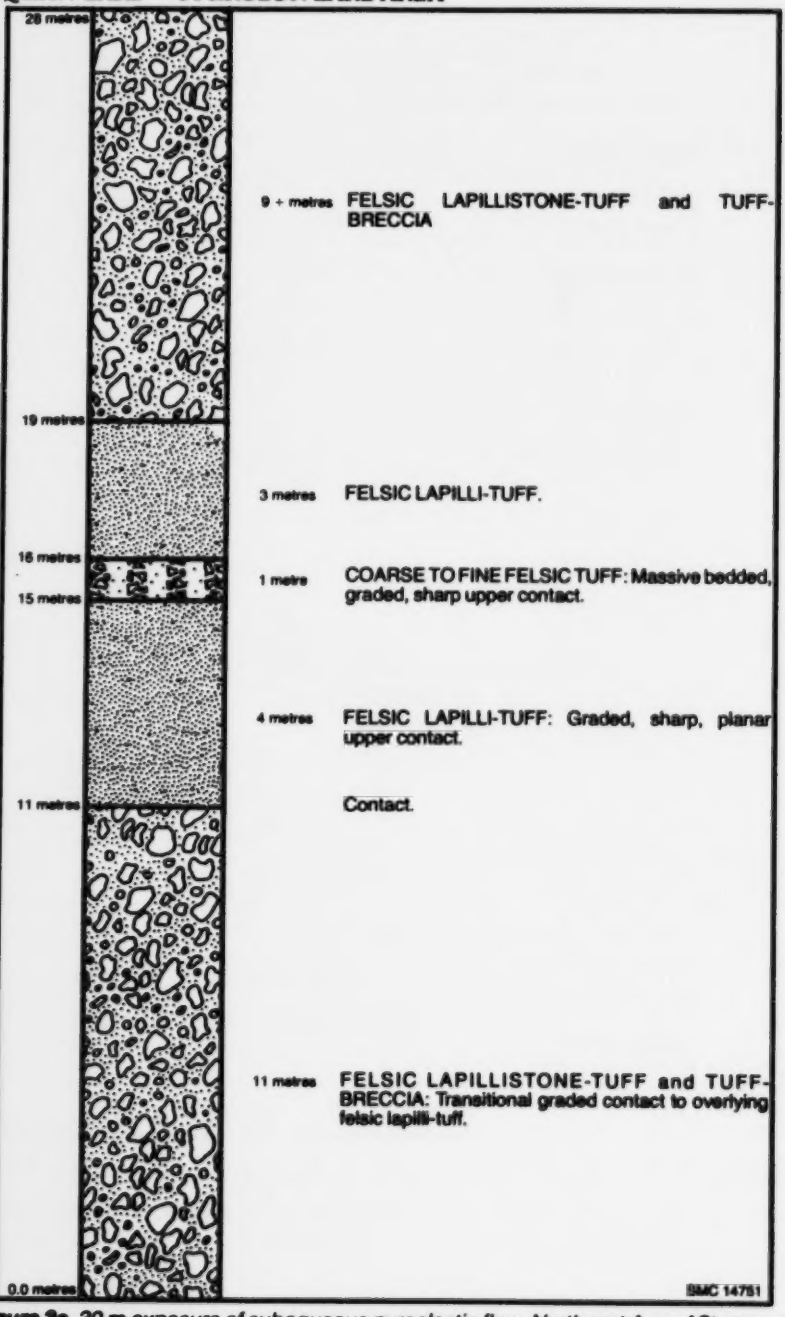

28 metres
19 metres
16 metres
15 metres
11 metres
0.0 metres
9 + metres FELSIC LAPILLISTONE-TUFF and TUFF-BRECCIA
3 metres FELSIC LAPILLI-TUFF.
1 metre COARSE TO FINE FELSIC TUFF: Massive bedded, graded, sharp upper contact.
4 metres FELSIC LAPILLI-TUFF: Graded, sharp, planar upper contact.
Contact.
11 metres FELSIC LAPILLISTONE-TUFF and TUFF-BRECCIA: Transitional graded contact to overlying felsic lapilli-tuff.
BMC 14751

Figure 3c. *30 m exposure of subaqueous pyroclastic flow, Northeast Arm of Sturgeon Lake.*

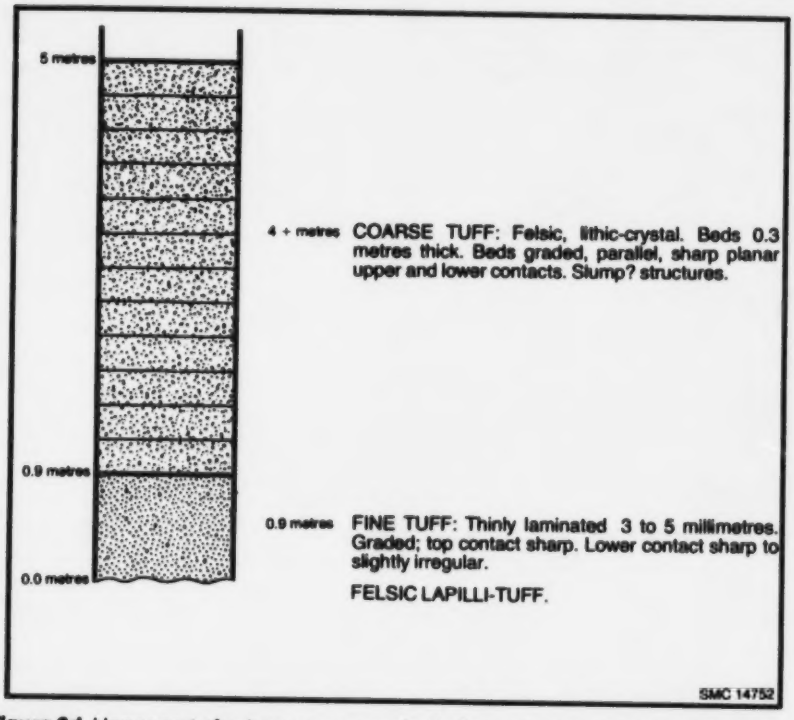

5 metres
0.9 metres
0.0 metres
4 + metres
COARSE TUFF: Felsic, lithic-crystal. Beds 0.3 metres thick. Beds graded, parallel, sharp planar upper and lower contacts. Slump? structures.
0.9 metres
FINE TUFF: Thinly laminated 3 to 5 millimetres. Graded; top contact sharp. Lower contact sharp to slightly irregular.
FELSIC LAPILLI-TUFF.
SMC 14752

Figure 3d. *Upper part of subaqueous pyroclastic flow sequence, Northeast Arm of Sturgeon Lake.*

lapilli-tuff units. Local possible flaser structure in the fine tuff suggests subsequent subaqueous reworking.

Contacts between fine tuff and coarser units are generally sharp and nearly planar though the lower surface is locally slightly irregular. Well bedded tuff units occur at the north end of the Northeast Arm and may represent a distal facies subaqueous pyroclastic flow.

The coarse pyroclastic units of lapillistone to tuff-breccia and lapilli-tuff were possibly deposited by subaqueous currents as postulated for the Ohanapecosh Formation by Fiske (1963a). They are characterized by poor sorting and poorly defined graded bedding although the beds of lapilli-tuff to coarse tuff tend to show much better graded bedding. The thinner beds of fine to coarse tuff were possibly formed by ash falls. They are commonly graded and moderately sorted. The finely laminated units composed of fine tuff possibly represent background settling of fine ash suspended in the waters of the volcanic-sedimentary basin. Fiske (1963a) compared subaqueous pyroclastic flows with sedimentary turbidite sequences with respect to deposition mode.

Finely laminated, water-laid, felsic to intermediate tuff units were also observed within the upper portion of mafic to intermediate assemblage A where they occur as thin interflow units between pillowed flows. They show an irregular lower surface where they infill the interstices between the pillows, and a planar upper surface.

Spherulitic Tuff

A felsic metavolcanic tuff unit within the felsic to intermediate, predominantly pyroclastic, assemblage north of East Bay contains preserved spherulitic structures (not coded on map-face). This unit weathers white and is dark grey to almost black on the fresh surface. The spherulites weather as white spheres approximately 1 to 3 mm in diameter. In thin section, spherulites were found to constitute upwards of 50 percent of the rock, while lobate subhedral quartz and corroded plagioclase phenocrysts, and an interstitial mesostasis of fine-grained quartz, plagioclase, chlorite, biotite, carbonate, and opaque oxides form the remainder. The spherulites have four main growth forms: (1) single spherulites; (2) compound forms composed of several coalescing spherulites; (3) single or compound spherulites growing around a quartz crystal; and (4) single or compound spherulites growing around a plagioclase crystal. Local symplectic intergrowths at the border of a particular spherulite with an adjacent plagioclase grain may have formed during metamorphism.

Porphyry

Porphyry includes units that are intrusive into the various metavolcanic assemblages and that appear to be the subvolcanic or hypabyssal equivalents of the felsic to intermediate metavolcanics. They are distinguished primarily on their intrusive relationships although several units were interpreted as intrusive porphyries on the basis of the similarity of their textures to known intrusive units. Some of these interpreted porphyries may be crystal tuff or flow units.

In thin section the porphyries are composed of plagioclase and quartz phenocrysts set in a matrix of fine-grained quartz, plagioclase, chlorite, muscovite, carbonate, and pyrite. They are trondhjemite in composition. Quartz grains locally have an amoeboid, lobate outline. Subhedral plagioclase crystals are sodic in composition and variably altered to sericite. Local myrmekite suggests an intrusive hypabyssal origin.

A "mixed porphyry" unit is located along the west shore of the Northeast Arm, about 2.5 km northeast of Fraser Lake. This unit comprises two phases: (1) a fine-grained mafic phase that occurs as clot-like or wispy entities in (2) a coarse-grained quartz-feldspar porphyry phase.

The mafic masses range in size from 2.5 cm to 0.6 m and can have the appearance of discrete fragments with relatively sharp borders, or of wispy irregular blobs with irregular, almost transitional borders, or of fine-grained mafic segregations within the felsic phase. Locally these mafic masses have a fine vesicular appearance. Two to three percent quartz and feldspar phenocrysts are locally present within them. The mafic masses comprise anywhere from 10 to 40 percent of this unit. Locally patches of the porphyry phase appear to have been engulfed in the mafic phase.

Thin section study shows this unit to be highly variable from an intrusive-textured quartz-feldspar porphyry to a fragmental lithic-crystal tuff or volcanogenic sedimentary rock. These variations may represent different levels within this unit, the intrusive textures reflecting a hypabyssal level, and the fragmental textures a level at which this unit broke through to the surface as effusive fragmental volcanism.

The quartz-feldspar porphyry from the "mixed" unit is composed of medium- to coarse-grained crystals of subhedral to euhedral slightly saussuritized plagioclase, and subhedral to euhedral (dipyramidal), subangular to rounded and slightly lobate quartz crystals, the majority of which show pronounced undulatory extinction, set in a fine-grained matrix of quartz, plagioclase, sericite, chlorite and carbonate. Fine clots composed of sericite, carbonate, and epidote are locally present in addition to the basaltic-textured elliptical clasts and wisps of intermediate metavolcanic composition.

The fragmental sample from the "mixed" unit is composed of medium- to coarse-grained crystals of subhedral to anhedral, commonly shattered quartz, subhedral, zoned, locally highly altered plagioclase, and lithic fragments of ash to lapilli size. The quartz phe-

nocrysts are grey to light blue and vary in size from 1 by 1 mm to 2.5 by 2.5 cm, while the plagioclase grains vary from 1 to 15 mm in length. The lithic fragments are composed of very fine-grained quartz and plagioclase with microphenocrysts of plagioclase set in a fine ash matrix. Mafic wisps composed of plagioclase, chlorite, carbonate and ilmenite, and discrete basaltic-textured areas or clasts are also present.

The author considers that the relationships between the two phases of the "mixed" unit may be explained by the mixing of two magmas in a hypabyssal or subvolcanic position where the mafic semi-consolidated phase was intruded by a quartz-feldspar porphyry crystal mush. Reaction between the two magmas could explain the general transitional contacts between the two phases. The feldspar and quartz phenocrysts in the mafic phase could have been intruded in this phase during intrusion while both phases were in a plastic state.

Felsite

Felsite includes those fine to very fine grained siliceous and massive units which are predominantly present within assemblages B and E and which the author considers to be the intrusive equivalents of volcanic rocks of the same composition. While some of these units show definite intrusive relationships the origin of others is uncertain.

In general these units vary in width from one to several metres and are traceable along their length for a few metres to in excess of 100 m. They generally trend approximately parallel to stratigraphy, though some do show cross-cutting relationships. They weather white, pink, and locally brown. They are generally massive to weakly foliated.

In thin section felsite is seen to be composed of equigranular subhedral sodic plagioclase and quartz with interstitial chlorite, sericite, carbonate, and pyrite. Locally they are microporphyritic. The chlorite has a distinctive light green to green pleochroism and is present in amounts varying from 3 to less than 10 percent. They generally contain 1 to 2 percent finely disseminated pyrite. Symplectic intergrowth between quartz and plagioclase is common, locally forming pseudo-spherulitic structures.

Partial chemical analyses, by Geoscience Laboratories, Ontario Geological Survey, of two grab samples collected by the field party from these units indicate that they are highly siliceous (80 percent SiO_2) and sodic (6 percent Na_2O) with respect to the associated felsic to intermediate pyroclastic units of assemblage B.

CARBONATE BRECCIA UNIT

A carbonate breccia unit is exposed on the central islands in the Northeast Arm of Sturgeon Lake; the major portion of this unit is underwater. Its strike length is approximately 5.5 km and its average width is 60 m. For most of its length it lies either within the upper stratigraphic part of the felsic to intermediate, pyroclastic, assemblage B, or at the contact of this assemblage and the overlying east-facing, pillowed and amygdaloidal, mafic to intermediate, assemblage D. Assemblage D contains several pillow breccia zones indicative of hyaloclastic deposition. The breccia unit is a volcanogenic sedimentary rock composed of hyaloclastic material admixed with material picked up or derived by erosion from the felsic to intermediate pyroclastic assemblage within which, and locally over which it lies. The author believes that the carbonate breccia unit was a hyaloclastite that was formed by granulation of fluid lava at the lava-water interface and then was subsequently reworked either by the swirling action of the steam formed at the lava-water interface or by subaqueous current action.

The carbonate breccia unit weathers brown, red-brown, dark green to black, with various yellow, orange, and green hues. Similar colours though of a lighter shade are visible on the fresh surfaces.

This unit varies from massive to weakly foliated to strongly schistose. The lapilli-tuff-sized clasts generally are aligned parallel to their long dimensions, probably reflecting both deposition in a subaqueous environment and later deformation.

The carbonate breccia unit has been tentatively subdivided into three subunits: (1) mixed breccia, (2) layered breccia, and (3) isolated breccia. The mixed breccia and layered breccia comprise the western and eastern portions respectively of the main unit, while the occurrences of isolated breccia lie within felsic pyroclastic rocks.

Locally the mixed breccia subunit possesses what is apparently a primary bedding stratification. The layered breccia subunit is characterized by a primary, possibly graded, stratification reflecting the reworked origin of this subunit. The subunits roughly correspond (Table 4) to the genetic classification of hyaloclastites proposed by Silvestri (1963).

The mixed breccia subunit consists of three components: block and bomb-shaped mafic volcanic clasts, carbonatized lapilli-tuff-sized clasts or shards, and a carbonate-chlorite matrix. Felsic volcanic clasts are locally present, but their erratic distribution suggests they are foreign inclusions derived from the erosion of the original felsic to intermediate volcanic pile. The mafic volcanic clasts are highly variable in abundance, size, and shape; they weather high and locally exhibit fine-grained white, possibly chilled, borders. Locally they have the appearance of malformed or disrupted pillows (Photo 10).

Up-section, from west to east, the mixed breccia changes from a unit containing both abundant felsic volcanic clasts (admixed xenoliths of Silvestri 1963) and large mafic volcanic clasts to a unit where mafic lapilli-tuff-sized clasts predominate, akin to Silvestri's (1963) "initial hyaloclastite breccia" — "hyaloclastite breccia", and "common hyaloclastites" respectively (see Table 4).

The layered breccia subunit is a stratified member (Photo 11) composed of black lapilli-tuff-sized clasts set in a chlorite-carbonate-stilpnomelane matrix (stilpnomelane was identified in thin section and confirmed by X-ray analysis by the Geoscience Laboratories, Ontario Geological Survey). It is intercalated with amygdaloidal pillowed flows.

The isolated breccia subunit comprises at least 20 individual scattered bodies that lie within felsic to intermediate pyroclastic host rocks. There are two types.

Type 1 are subrounded bodies which vary in size from less than 0.3 by 0.3 m up to 1.2 by 0.6 m; their maximum depth extension is not known. Differential weathering of these

TABLE 4. CLASSIFICATION OF CARBONATE BRECCIA UNIT ACCORDING TO CLASSIFICATION OF SILVESTRI (1963).

Carbonate Breccia Unit (This Study)	Hyaloclastite Classification (Silvestri 1963)	Description (Silvestri 1963)
Mixed Breccia Subunit	Initial Hyaloclastite Breccias	Brecciated material, often with admixed xenoliths
	Hyaloclastite Breccias	Brecciated material in hyaloclastic matrix
	Common Hyaloclastites	Composed exclusively of fine glassy fragments
Layered Breccia Subunit	Stratified Hyaloclastites (in situ)	Common hyaloclastites stratified due to swirling action of steam produced at lava-water interface
Isolated Breccia Subunit	Reworked Hyaloclastites	Hyaloclastites reworked, recemented, stratified or mixed with sedimentary environment

OGS 10530

Photo 10. *Mixed breccia subunit of carbonate breccia unit showing mafic metavolcanic inclusions, with the appearance of malformed or disrupted pillows, set in matrix of carbonatized lapilli-tuff-sized clasts. From island 1200 m northeast of Morgan Island.*

bodies gives the outcrops a potholed appearance. They all exhibit a chill or reaction margin less than 2.5 cm thick. These bodies now plunge subvertically but their original orientation with respect to the volcanic pile is not known. They consist of carbonatized lapilli-tuff-sized clasts set in a chlorite-carbonate matrix.

Type 2 are elongated lensoid-shaped bodies which average 1.5 by 0.3 m. One occurrence, with dimensions of at least 6 by 1.8 m contains slightly carbonatized 8 to 10 cm rounded inclusions of intermediate intrusive material. These bodies are also surrounded by a narrow chill or reaction margin, but, as well they are internally layered with the layers generally parallel to their long dimension. They have the appearance of eroded blocks of the layered breccia. Internally they also are composed of carbonatized lapilli-tuff-sized clasts set in a chlorite-carbonate matrix. Both types contain rare admixed felsic volcanic inclusions.

Three origins for these isolated breccia bodies are possible.

1. They are erosional products derived from the main portion of the carbonate breccia unit to the west.
2. After the carbonate breccia unit was laid down, felsic volcanic activity continued resulting in the partial explosive disruption of the carbonate breccia strata. Detached fragments from this body were then caught up within the felsic volcanic debris. The marginal rims around these bodies were produced by reaction with the still warm pyroclastic material.
3. These bodies were originally intrusive into an unconsolidated, water-saturated pile of felsic pyroclastics. The marginal rims represent the chilled outer margins of these con-

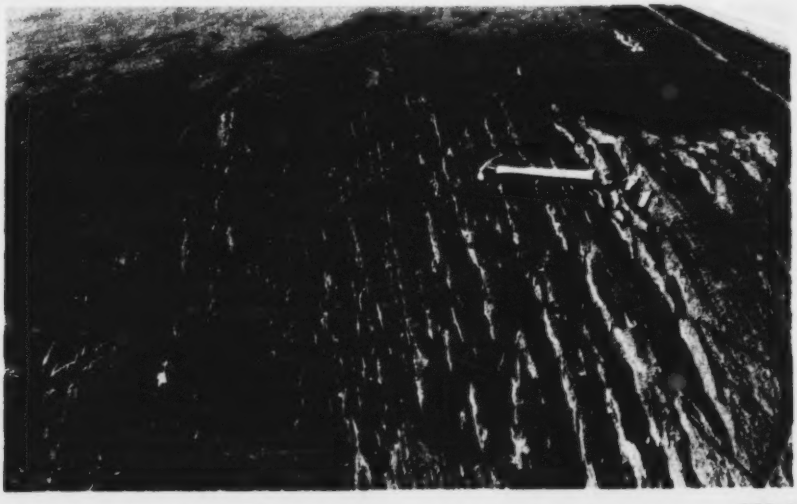
duits, which possibly acted as feeders for the main carbonate breccia unit. Their internal fragmental nature is a result of granulation resulting from the interaction of hot lava and water. The small size, random distribution and orientation, of these layered bodies are more difficult however to explain by intrusive processes.

Petrography

Thin sections cut from several samples collected by the field party were examined to determine the texture, structure, and mineralogy of the lapilli-tuff-sized clasts and the interclast matrix.

The clasts are generally in the 2 to 10 mm size range although locally 2 cm clasts are present. Sorting is poor to moderate: local size gradations are suggestive of graded bedding. The clasts vary from subangular to subrounded in shape. They are internally zoned with respect to texture, mineralogy, and type of iron carbonate present. The zonation is generally transected by the clast boundaries indicating perhaps that several of these clasts originally constituted a portion of larger, now fragmented entities, perhaps lava globules ruptured by the hyaloclastite-forming process. The clasts are generally finely amygdaloidal. Locally compound fragments are composed of an internal, basaltic-textured portion and an outer fine-grained portion, possibly equivalent on a small scale to the internal portions of a pillow and its selvage respectively. Locally a pseudowelded appearance may indicate deformation (by weight compaction) of primary glassy shards.

Following the method outlined by Friedman (1971, p.511-531), stained acetate peels were made from several grab samples collected by the field party to determine the nature and distribution of the carbonate minerals. These show that the lapilli-tuff-sized clasts contain ferroan dolomite and ankerite, while the interclast matrix contains ferroan dolomite which has a lower iron content than that within the clasts and calcite. The calcite might be a later addition introduced during deformation and metamorphism, as it was only observed in the matrix, and is characteristically present within the entire carbonatized zone along the Northeast Arm.



OGS 10531

Photo 11. *Layered breccia subunit of carbonate breccia unit, showing internal stratification. Differential weathering could reflect compositional differences or graded bedding. From island 90 m east of northeast tip of Morgan Island.*

Quartz is present as amygdaloidal fillings within these clasts, and as equigranular polygonal aggregates comprising a portion of the less completely carbonatized interclast matrix. It may represent alteration of volcanic glass or deposition by volcanic exhalative or later sedimentary intergranular solutions.

Plagioclase and carbonate pseudomorphs after plagioclase were observed in the internal basaltic-textured portions of these clasts.

The mafic minerals include chlorite and stilpnomelane. Stilpnomelane may be diagenetic or may have formed under low greenschist facies metamorphism (French 1973).

Laberge (1966a,b) reported that stilpnomelane forms as an alteration of original volcanic shards in pyroclastic rocks associated with iron formations studied in Australia and South Africa.

Fuchsite, recognized in outcrop by its micaceous habit and pale green colouration, is locally present, usually concentrated along shear planes and in the interclast matrix. The green micaceous mineral in grab samples was separated and confirmed as fuchsite by X-ray determination and by atomic absorption analysis of the concentrate (analyses by Geoscience Laboratories, Ontario Geological Survey). Chromium was found to be present in amounts in excess of 1 percent thus confirming the mineral as fuchsite (Deer *et al.* 1966).

Opaque Fe-Ti oxides are ubiquitous, generally concentrated within the clast interior. Locally, euhedral carbonate rhombs, probably dolomite, appear to have nucleated around clots of opaque oxides. The presence of these opaque oxides within the carbonate breccia unit is reflected in the magnetic response of this unit (Barlow 1974a) that is much higher than the response of the surrounding felsic to intermediate metavolcanics.

Table 5 gives the major and trace element analyses for grab samples collected from each subunit of the carbonate breccia unit by the field party. The low silica, alumina, and alkalies, and high iron, magnesia, and calcium values are reflected in the present mineralogy of this unit. While the analyses are characteristic of an ultramafic rock, the author can not rule out the possibility that the original composition was basaltic subsequently modified by palagonitization, devitrification and diagenetic alteration, and later dynamic and thermal metamorphism.

Table 6 shows the average and maximum abundances of trace elements in 31 grab samples collected by the field party from the carbonate breccia unit. The high Cr, Ni, and Ti, and moderately high Co and V values are significantly higher than those published for mafic volcanic rocks and, are in fact, more closely akin to elemental abundances for ultramafic rocks. It is of interest that a rock unit from the Steeprock Lake area is similar in composition to the carbonate breccia (Joliffe 1955; Shklanka 1972). There, a so-called "ash-rock" unit was described by Joliffe as an ultramafic tuff of picritic composition.

Origin of Carbonate Breccia Unit

On the basis of the field relationships, internal structures and textures, mineralogy and chemistry, described above, the author suggests that the carbonate breccia unit is essentially a hyaloclastic deposit. A suggested model for the development of this unit is that following or concurrently with the waning stages of an interval of felsic volcanic activity, a period dominated by mafic volcanism began. Initial outpourings comprised hot, highly fluid lava which poured out into a subaqueous relatively shallow water environment. Lava-water interactions produced lava droplets or globules which were quickly enclosed by an outer chilled glassy margin, possibly of palagonitic composition. The inner more slowly cooled core of these globules crystallized volcanic-textured phases. Transitions between these two modes would be represented by an internal zonation. Where chilling was rapid, differential thermal stresses resulted in the explosive granulation of these globules. In these granulated units, the contrasting appearance of the fragments is a reflection of what portion, or portions, of these globules the fragment represents, whether it be outer glassy mar-

TABLE 5. MAJOR AND TRACE ELEMENT ANALYSES OF CARBONATE BRECCIA UNIT.

Major Elements	**1**	**2**	**3**
SiO_2	29.50	31.50	31.80
Al_2O_3	3.88	5.84	4.36
Fe_2O_3	1.89	1.08	0.99
FeO	6.65	10.50	8.77
MgO	6.80	7.31	11.00
CaO	24.40	16.70	15.60
Na_2O	0.11	0.18	0.11
K_2O	0.02	0.41	0.02
TiO_2	0.67	0.84	0.84
P_2O_5	0.21	0.22	0.07
S	0.02	0.02	0.14
MnO	0.24	0.37	0.22
CO_2	22.60	24.00	24.00
H_2O^+	2.32	2.44	1.91
H_2O^-	0.04	0.05	0.03
Total	99.30	101.50	99.80
Specific Gravity	2.77	2.81	2.87
Trace Elements	**1**	**2**	**3**
Ag	<1	<1	<1
As	20	<3	10
Ba	<150	<150	<150
Be	<3	<3	<3
Co	50	55	75
Cr	3700	3400	4000
Cu	140	160	180
Ga	<10	<10	<10
Li	15	6	25
Mo	<10	<10	<10
Ni	470	480	890
Pb	<10	<10	20
Sb	1	<1	1
Sc	25	<20	<20
Sn	<10	<10	<10
Sr	50	200	500
V	160	160	160
Y	<20	<20	<20
Zn	50	55	80
Zr	35	30	30

NOTES

Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto. Major elements given in weight percent; trace elements in parts per million.

SAMPLES

	Sample No.	Latitude	Longitude	Lithology
1	1-40-3D-4	50.0736	90.6361	Matrix of mixed breccia subunit
2	1-43-2C-4	50.0722	90.6380	Layered breccia subunit
3	1-40-2B-2	50.0652	90.6375	Isolated breccia subunit

gin, zoned interior, or central crystalline core. Where cooling was less rapid, granulation did not occur and these globules remained as coherent entities, though compaction, while still in the glassy state, produced pseudowelded textures. Reworking by water no doubt determined to some extent the final forms of these fragmented globules. Felsic fragments were picked up from the unconsolidated pyroclastic units, while the mafic volcanic fragments represent larger lava globules or pillows that cooled slowly thus retaining their shape or fracturing into blocky angular bodies.

The layered breccia subunit represents a subaqueously deposited and/or reworked member akin to Carlisle's "aquagene tuff" (Carlisle 1963). During the formation of palagonitic glass, and its subsequent breakdown, solutions were formed capable of effecting a redistribution of major and minor oxides, and trace elements. Perhaps silica, alumina, and alkalies were effectively leached from this unit, resulting in relative upgrading of the iron, magnesia, and calcium values. Recent hyaloclastic material dredged from the sea floor is often found to be quite rich in carbonates (Bonatti 1963, 1966, 1967). Nayadu (1962, 1964) has reported that in one hyaloclastic sample, alteration subsequent to palagonitization produced interclast crypto-crystalline silica as well as carbonates and zeolites. Bonatti (1963, 1967) and others have suggested that the solutions arising out of hyaloclastitic-type volcanism are also capable of leaching, concentrating, and subsequently mobilizing such elements as Fe, Mn, as well as Cr, Ni, and Co, which may explain the ultramafic trace elemental abundances though there is no a priori evidence to suggest these rocks were not ultramafic to begin with. The common alteration products of palagonite include zeolites and clay minerals, specifically montmorillonite as well as carbonate. At Sturgeon Lake these clay minerals could have been transformed to stilpnomelane and also chlorite during diagenesis and/or metamorphism. It is possible that the leached silica was subsequently involved in a period of deformation and metamorphism and is now represented in the several gold-bearing quartz-carbonate sulphide veins that contain fuchsite and comprise several old gold showings located along the Northeast Arm of Sturgeon Lake. Quartz veins that cut the carbonate breccia unit commonly carry anomalously high gold and copper

TABLE 6. AVERAGES AND MAXIMUM VALUES OF TRACE ELEMENT ANALYSES OF 31 GRAB SAMPLES FROM THE CARBONATE BRECCIA UNIT.

Trace Elements	Average	Maximum Value
Cr	1,500	4,000
Co	75	300
Cu	200	700
Au*	10 ppb	1,500 ppb
Fe*	7.4%	12.6%
Mn	200	800
Hg*	50 ppb	90 ppb
Ni	700	1,500
Rb*	18	81
Ag	1	5
S	0.05%	0.31%
T	4,000	10,000
V	175	300
Zn	100	300

NOTES

* Only 5 samples analyzed

Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto. Values in parts per million, except as noted.

values indicating that this unit should perhaps be examined from the viewpoint of exploring for large tonnage, low grade gold-bearing, in addition to Ni, Cr, and Ti, deposits.

Gordanier (1975) who did an undergraduate thesis study on the carbonate breccia unit suggested that it might represent a subaqueous redeposited ultramafic tuff and that the internal bedding structures and strongly bimodal size distribution of clasts may indicate that this unit was transported and deposited as a density current. Geochemical studies on this unit indicated (Gordanier 1975):

...the distribution of Fe is controlled by iron-rich minerals in the clasts as well as in iron carbonates. Mn is probably found in the ankerite lattice replacing Ca and also in silicate minerals in the clasts. Co, Cr, Cu and possibly Zn are also found in the clasts. Correlation coefficients indicate that ultramafic to mafic clasts may be controlling their distribution. Sr is probably controlled by carbonates and S controlled by sulphides which also may control distribution of Ni, Co, and Cu. Lithium and Ba distribution is very erratic and no conclusions can be drawn.

Metasediments

A major sedimentary assemblage, that has been metamorphosed under greenschist, amphibolite, and hornblende-hornfels facies conditions, is exposed over the southern and eastern parts of the map-area. This assemblage is lithologically heterogeneous, comprising an interbedded sequence of wacke, arenite, siltstone, argillite, and conglomerate, with minor slate, chert, and sulphide facies iron formation units. Locally these sedimentary rocks have been fenitized by the Sturgeon Narrows Alkalic Complex or intruded and metamorphosed by the Vista Lake, Flindt River, Vanessa Lake, and eastern granitic intrusions.

Thin interflow sedimentary rocks and reworked tuffs are also present in the mafic to intermediate metavolcanic assemblages east of the Northeast Arm of Sturgeon Lake, and volcanogenic sedimentary rocks are intercalated with, and represent a facies change from the intermediate to felsic, predominantly pyroclastic assemblage, exposed along the upper part of the Northeast Arm. Most of the volcanogenic sedimentary units have been grouped with the associated felsic to intermediate metavolcanic units on the map.

In metasediments of greenschist facies, some primary clastic textures are preserved. Larger clastic quartz and plagioclase grains retain their original outlines but the matrix has recrystallized to a fine-grained aggregate of quartz, plagioclase, and subparallel micaceous minerals. Lithic clasts have recrystallized and except for textural variations and contrasting mafic mineral distribution are difficult to distinguish from the matrix. Plagioclase grains, exhibiting preserved oscillatory zoning, may reflect an original volcanic derivation for these metasediments (see Photo 12). With increasing grade of metamorphism, the original clastic texture has been obliterated and recrystallization leads to the development of micaceous minerals forming both a (schistose) planar foliation and a crudely defined compositional layering. Near the eastern granitic complex, granodioritic and trondhjemitic gneisses were recognized as being possibly of sedimentary derivation by the presence of preserved sedimentary structures and rare relict clastic textural features.

Locally an equigranular granoblastic-polygonal texture was produced under hornblende hornfels facies conditions. In muddy wacke units porphyroblastic growth gives rise to knotted schist.

In the southeast portion of the map-area layers and rafts of the metasediments occur within the Vista Lake Intrusion. They are cut by feldspathic mobilizates and leucocratic aplitic dikes of syenitic and monzonitic composition and locally show porphyroblastic plagioclase growth.

The mineral components of greenschist facies metasediments are quartz + plagioclase (albite) ± microcline (rare) + muscovite ± biotite ± chlorite (chlorite-biotite subfacies) ± carbonate ± epidote. The mineral assemblage of upper greenschist to lower amphibolite facies metasediments is quartz + plagioclase ± microcline (rare) + muscovite

+ biotite ± hornblende ± garnet. Andalusite and micaceous porphyroblasts may have formed under high greenschist to low amphibolite or hornblende hornfels facies conditions.

Accessory minerals include zircon, sphene, opaque oxides, pyrite, pyrrhotite, and locally graphite.

Metasediments within several 10's to 100 m of their contact with the Sturgeon Narrows Alkalic Complex have been weakly fenitized with the development of a pale lavender coloured pleochroic amphibole (riebeckite?) rare garnet, and strongly feldspathized zones.

Sandstone

The sandstones are predominantly feldspathic and lithic-feldspathic wacke (Pettijohn and Potter 1972), locally variable to arkosic arenite, muddy wacke, and quartz-eye feldspathic wacke. Wacke is generally interbedded with siltstone-argillite members and conglomerate lenses. The wacke is locally pebbly, containing less than 25 percent pebbles that are predominantly of intermediate volcanic composition, but minor chert, felsic and mafic volcanic, quartz aggregate, and rare siltstone pebbles are also present. Bedding is well developed and graded bedding is locally present, though determination of facing directions is hampered by alteration, porphyroblastic growth, and recrystallization under medium grade metamorphic conditions. Sorting is poor to locally moderate.

Bed thickness is variable. In the area north of Coveney Island beds are commonly 5 to 15 cm thick but some beds, especially of the quartz-eye feldspathic wacke, are 0.5 to 2 m thick. Bed thickness decreases to the east and southeast. In the central area of metasediments, between the Sturgeon Narrows and Vista Lake Intrusive Complexes, the wacke beds average 2.5 to 10 cm in thickness with local units attaining thicknesses of 20 to 60 cm. Here also, bed thickness decreases to the south, and in addition the wacke units appear to have a greater mudstone content to the south as is shown by the common occurrence of porphyroblastic or knotted schists. In the eastern area of metasediments, thickness of wacke beds is in the 2.5 to 10 cm range, and locally up to 20 to 60 cm. The wacke beds are commonly separated by 2.5 to 7.6 cm siltstone-argillite members which are generally finely (1 mm) laminated.

The more arenaceous rocks weather almost white, and the wacke units are light grey and light green to dark grey and dark green. Local brownish hues characterize the iron-rich, generally more siliceous, units. On fresh surfaces they have the same colours, only of a lighter shade. The colour is darker as the metamorphic grade increases, or, in muddy wacke, as the pelitic content increases.

Quartz-eye feldspathic wacke to locally arkosic arenite is found on the islands west and north of Coveney Island. It is characterized by the presence of upwards of 40 to 50 percent, 1 to 3 mm diameter, angular to subangular, bluish quartz grains that give the rock a pseudoporphyritic appearance. It is variably pebbly with local accumulations of or gradations to conglomerate. It weathers white to light grey, and is light grey on the fresh surface. It occurs in thick, poorly sorted, massive beds locally separated by thin, locally laminated, siltstone, and siltstone-argillite members (Photo 12). It is locally interbedded with feldspathic wacke.

Locally ferruginous metasediments dominantly of cherty wacke composition contain 1 to 5 percent finely disseminated sulphides. Surface alteration of the sulphides gives these rocks a brown to red-brown hue.

Siltstone, Argillite

Siltstone-argillite units are commonly interbedded with wacke and locally form discrete units from one to several metres thick as on the southern part of Vanessa Lake. Pyrite- and

OGS 10532

Photo 12. *Photomicrograph of metasediments from island at entrance to East Bay showing quartz-eye feldspathic wacke (top) in contact with siltstone (bottom). Grain in right central position is zoned plagioclase, possibly reflecting volcanic derivation. Crossed nicols, 6X.*

pyrrhotite-bearing ferruginous metasedimentary units are commonly intimately interbedded with siltstone-argillite units, while graphite is found in argillaceous units. The sulphide minerals form discrete beds, show soft sediment deformation features, and are probably syngenetic.

Siltstone and argillite weather pale grey to pale brown while on the fresh surface they are grey, grey-brown, and black. Locally they are slightly ferruginous where associated with ferruginous wacke units. Primary textures have been destroyed and the rocks now have a recrystallized, generally equigranular-polygonal texture. The mineral assemblage in these rocks is similar to that of the wacke interbeds though generally the mafic content is appreciably higher, and locally andalusite porphyroblasts are developed.

These units are generally thinly bedded on the order of 2.5 to 7.6 cm and are commonly finely laminated. Locally they are very finely cross-bedded and rarely rippled and may in fact be C divisions of Bouma sequences. The local presence of sandy lenses may be examples of flaser structure.

These units locally show the effects of soft sediment deformation including plastically formed flow folds (Photo 13).

Knotted Metasediments

Muddy wacke, argillite beds, and thin pelitic intervals locally contain porphyroblasts of andalusite and micaceous (muscovite) aggregates. These units are shown as "knotted metasediments" on Map 2420 (back pocket). The micaceous aggregates are possibly an alteration of andalusite; locally andalusite cores are surrounded by mixtures of quartz,

OGS 10533

Photo 13. *Soft sediment deformation structures in siltstone-argillite from small island north of Coveney Island, East Bay. Plastically formed flow folds produced by initial soft sediment deformation may have also been affected by later deformation.*

muscovite, and plagioclase possibly representing incipient andalusite which reverted in part to its reactant minerals (Joplin 1968, p.117). The mineral assemblage is generally quartz + plagioclase (oligoclase) + muscovite + biotite + andalusite. The porphyroblasts range in size from 0.5 to 2.5 mm and comprise from 5 to 30 percent of the rock unit. The finer grains were only identified in thin section and it is possible that during the field mapping the local presence of andalusite could have gone undetected. Andalusite has grown both as xenoblastic rounded grains lacking any crystal faces and as idioblastic euhedral grains. Texture is knotted or maculose wherein the porphyroblasts are evenly distributed and of the same approximate size. Some andalusite grains have grown unoriented with reference to internal planar structures; more commonly they have grown in the crests and troughs of small-scale fold plications (crenulations). Locally they are of the variety

chiastolite with growth controlled, generally quartz, inclusions. *Sensu stricto*, most of these porphyroblasts are poikiloblastic. Helicitic structure is common, suggesting that porphyroblasts are post-tectonic. Andalusite was not observed in the metasediments of amphibolite and hornblende hornfels facies rank adjacent to the Vista Lake Intrusion and the eastern granitic complex.

Conglomerate

Pebbly wacke variable to pebble conglomerate and locally cobble conglomerate occurs as lensoid accumulations interbedded with the wacke and siltstone-argillite members. The conglomerates are generally matrix supported, the matrix being the same variety of wacke as the immediate wacke interbeds. Clasts are dominantly volcanic (no granitoid clasts were observed), and comprise in order of decreasing abundance: intermediate volcanic, chert, and rare mafic volcanic and siltstone clasts. Clasts are generally subangular to locally subrounded or ellipsoidal in shape having possibly been stretched parallel to the prevailing foliation. They may reach 20 to 30 cm in diameter but generally average 3 cm.

The conglomerate member of the quartz-eye wacke in the Coveney Island area, at one location, contains large blocks (Photo 14) of intermediate agglomerate which, because of their size and coherence, probably travelled by mass movement breaking off and sliding down the palaeoslope of the original volcanic edifice coming to rest essentially concordant to bedding. Erosion was no doubt rapid and the matrix material was quickly deposited as evidenced by the coarseness and angularity of the grains comprising the enclosing wacke.

The metavolcanics and metasediments are intimately intercalated in the area west and north of Vista Lake. Volcanism and sedimentation may have occurred simultaneously. Local irregular mafic splotches in the metasediments, rather than being eroded fragments, may represent mafic volcanic spatter that erupted onto still wet, relatively unconsolidated, sediments. Local irregular volcanic masses, apparently suspended in the metasediments, may have been produced by intrusion of mafic volcanic rocks into unconsolidated sediments, followed by soft sediment deformation. Sedimentary inclusions are present within mafic to intermediate volcanic flows (Photo 15). Thus, some of these units rather than being conglomeratic in origin may be accidental and intrusive breccias.

Iron Formation

Sulphide iron formation is the most common iron formation within the map-area. It ranges in thickness from a few centimetres to about 6 m, but most units are less than 1.5 m. It is associated with siltstone-argillite members of the metasedimentary assemblage and with mafic to intermediate volcanic flows and tuffaceous units of the eastern metavolcanic assemblage G. It has been metamorphosed under both greenschist and amphibolite facies conditions.

A unit 5.5 m thick was intersected in one diamond drill hole by Sturgex Mines Limited (property 30 on map, see "Economic Geology") west of Vista Lake. It contains 15 percent sulphides (pyrrhotite 10-12 percent, pyrite 2-3 percent) as irregular bands and fracture plane fillings in a siltstone-argillite unit. A second drill hole intersection by Sturgex Mines Limited, possibly from the same unit, consisted of 3.6 m of brecciated sulphide-argillite material wherein pyrrhotite with minor pyrite comprise 30 to 40 percent of the rock. An exposure of sulphide facies iron formation, possibly equivalent to one of the drill hole intersections, is situated on the southeast shore of the lake situated approximately 900 m west of the northeast bay of Vista Lake. The sulphide zone is exposed for 2.1 m along strike, and is approximately 1.8 m thick. It is stratigraphically concordant to the surrounding metasediments, striking N70E and dipping 85N. It can be subdivided into four separate zones, from

OGS 10534

Photo 14. *Large block of intermediate lapillistone agglomerate set in pebble conglomerate host. Block is 3.6 m long and 1.2 m wide. It approximately parallels bedding. From island north of Coveney Island at entrance to East Bay.*

south to north: (1) a massive sulphide zone composed of up to 90 percent sulphides (pyrrhotite, with minor pyrite) and 10 percent siltstone-argillite; (2) a zone of disseminated sulphides in a siltstone-argillite groundmass; (3) a laminated zone comprising alternating sulphide and argillite laminae; and (4) a breccia zone of argillite fragments set in a sulphide groundmass. There is a repetition of the disseminated and laminated zones. The laminated zone shows convoluted and minor breccia structures that along with brecciation in the breccia zone could have formed as the result of soft sedimentary deformation. The unit is folded about east-trending, steeply west-plunging fold axes. Limonite and goethite alteration is present on the exposed surface. The outcrop had been recently trenched and blasted.

OGS 10535

Photo 15. *Sedimentary (wacke) inclusions in mafic to intermediate volcanic flow. Inclusions (light grey) are surrounded by dark grey rind of chilled mafic volcanic material. Both inclusion and rind weather high; the massive flow portion (medium grey) weathers low. From outcrop 900 m south of Squaw Lake and 300 m west of Vista Lake.*

In the East Bay area several units of sulphide facies iron formation are present within the metasediments exposed on the small islands and shoreline north of Coveney Island. A diamond drill hole by Selco Exploration Company Limited (property 25 on map) intersected a 3 m section comprising two subzones (1.1 and 1.4 m respectively) of massive (over 90 percent) pyrite-pyrrhotite with an intervening 0.5 m section containing 20 percent pyrite-pyrrhotite. The host rock is a very fine-grained, black, slightly graphitic, mudstone.

On the lake 1200 m east of East Bay, pyrite, minor pyrrhotite and trace chalcopyrite mineralization is associated with wacke and conglomerate. In the conglomerate the mineralization is confined to the matrix and the interstices between the felsic volcanic, chert, and rare intermediate volcanic clasts.

Several other thin layers of sulphide facies iron formation occur in the metasedimentary and metavolcanic assemblages in the Vista Lake-Vanessa Lake area. Those in the metavolcanic assemblage are associated with thin interflow argillaceous beds and tuff units while those in the metasedimentary assemblage are associated with weakly graphitic wacke and siltstone-argillite members. They comprise pyrite and pyrrhotite, locally with traces of chalcopyrite, in amounts variable from 2 to 40 percent. Few exposures of these units were found by the field party and most of the information has been obtained from diamond drill hole records in the Assessment Files Research Office, Ontario Geological Survey, Toronto.

Pyrite appears to be the dominant sulphide in those iron formations found in the western part of the metasedimentary assemblage, pyrrhotite in the east, but whether this is a reflection of the increasing metamorphic grade from west to east is not known.

These iron formation units are indicated by linear positive anomalies on the ground magnetic survey (Barlow 1974a, 1975a). As well they show a pronounced electromagnetic response, as is indicated on survey information submitted to the Assessment Files Research Office, Ontario Geological Survey, Toronto. These units are relatively continuous, and while it is not possible to use them as marker horizons, *per se*, they are useful for interpretation of palaeoenvironment.

METAMORPHOSED MAFIC INTRUSIVE ROCKS

The mafic intrusive rocks in the map-area comprise metamorphosed gabbro and diorite sills, dikes, and irregular masses, that have intruded the volcanic-sedimentary sequence. Due to the contrast in lithology, the mafic intrusive rocks were much easier to recognize where they have intruded felsic to intermediate metavolcanics and metasediments, than where they have intruded mafic to intermediate metavolcanics. The intrusive rocks characteristically exhibited the following combination of features: (1) texture which is generally medium-grained and, where preserved, equigranular, and subophitic to ophitic; (2) contact relationships that are generally sharp with local recognizable chill and inclusion zones; (3) structure that is generally massive to weakly foliated; (4) local presence of mauve to white titanite; (5) ground magnetic response (Barlow 1974a, 1975b) that reflects the local distribution of Fe-Ti oxides in these bodies; and (6) grain size that is generally medium to locally coarse. In the absence of observation of features (2), (4) and (5) these rocks are difficult to distinguish from medium-grained flow rocks particularly in amphibolite facies rocks.

The mafic intrusions appear to predate both regional metamorphism and deformation, because sill-like bodies predominate and the metamorphic rank of the intrusive bodies and the rocks they intrude is the same. Cross-cutting dikes locally end in or were feeders to these sill-like bodies. In the intermediate to felsic pyroclastic assemblage, the pyroclastic units appear to have been bowed up and locally truncated by intrusion of the mafic intrusive bodies. Locally small masses of intermediate to felsic pyroclastics have been torn off and incorporated within the intrusion. Overall, contacts are sharp but locally are irregular and discordant, as might be expected of intrusion especially into a semi-consolidated fragmental assemblage.

In places these bodies have a narrow, 2.5 to 12 cm chill contact zone. Fine amygdules were locally observed in the fine-grained marginal area of some intrusions. The intrusive rocks are massive to weakly foliated to locally schistose. They generally have a blocky weathering appearance in outcrop and more regularly oriented joint sets than the mafic to intermediate flow units.

Texturally these rocks are medium-grained equigranular to subophitic to locally ophitic. Primary textures are best preserved in massive, non-foliated, greenschist facies rocks. On the weathered surface they are green, grey-green to dark green for greenschist facies rocks and green, dark green, and locally black for amphibolite facies rocks.

Gabbro, Diorite

Gabbro and diorite are composed largely of plagioclase and amphibole with minor biotite locally. Quartz is variably present as fine-grained interstitial aggregates. Chlorite locally occurs in those intrusions which have been slightly sheared. Carbonate and epidote are common both as saussuritic pseudomorphs after plagioclase and as intergranular aggregates. Accessories include Fe-Ti oxides, sphene-titanite, apatite, pyrite and pyrrhotite.

In greenschist facies rocks the amphibole is generally of the tremolite-actinolite series. In habit it varies from pseudomorphic after pyroxene to recrystallized more anhedral grains locally replacing the plagioclase. It varies from 40 to 70 percent in amount. The plagioclase is generally albite though remnant oligoclase could be primary. Normal zoning of the plagioclase was locally observed. Saussurite pseudomorphs after plagioclase are prevalent within the mafic intrusive bodies that lie along the more highly deformed and altered Northeast Arm area.

In rocks of amphibolite facies rank the amphibole is dark green or dark blue-green hornblende. The plagioclase as determined in thin section is andesine-oligoclase. Primary textures are only locally preserved as recrystallization has transformed these rocks into granoblastic-decussate to locally banded amphibolitic rocks.

Fe-Ti oxides are ubiquitous generally as fine- to medium-grained skeletal grains in amounts of 1 to 3 percent, though local zones within these bodies contain upwards of 5 to 8 percent finely disseminated magnetite. The magnetite-rich zones are no doubt responsible for the local ground magnetic highs over these bodies (Barlow 1974a, 1975a). The magnetite-rich zones are also characterized by a slightly higher quartz content than is the main mass. Alteration of the titaniferous magnetite to sphene varies from a margin of sphene surrounding a central core of Fe-Ti oxide to complete replacement.

Feldspathic, epidote-rich pods and discontinuous veinlets within these bodies may be a result of deuteric or metamorphic reaction and/or segregation. Locally these bodies contain 2.5 to 7.5 cm diameter coarse-grained clots of plagioclase, quartz, disseminated magnetite and less than 10 percent amphibole. The clots may be late stage pegmatoid differentiates or segregations.

Table 7 gives the major and trace element composition and normative composition for nine grab samples, collected by the field party, of gabbro and diorite. The samples have a tholeiitic kindred and resemble the mafic to intermediate volcanic flows in chemical composition (see Table 3) suggesting that the volcanic and intrusive rocks came from the same source and that the intrusive bodies are the hypabyssal equivalents of the volcanic rocks.

Porphyritic Gabbro, Anorthositic Gabbro, Diorite

Several bodies of porphyritic gabbro (Photo 16), locally variable to diorite, intrude the metavolcanic assemblages in an area bounded to the west by the western shoreline of the Northeast Arm, and to the east by the Squaw Lake Alkalic Complex. They occur primarily as sills, locally as dikes and locally as porphyritic zones within medium-grained equigranular gabbro-diorite bodies. Local accumulations of upwards of 60 percent plagioclase phenocrysts are anorthositic gabbro in composition. The sills, dikes, and porphyritic zones vary from less than 1 to 30 m in width, but commonly are in the order of several metres wide.

While the sills were generally concordantly emplaced, local discordant contacts and intrusive breccia, composed of volcanic fragments caught up in a porphyritic gabbro intrusion, were seen. Individual intrusions show a relatively narrow, 5 mm to 5 cm, very fine-grained chill contact zone. They are generally massive to weakly foliated. Where they have been intensely sheared the matrix comprises fine-grained white-brown weathering chlorite and carbonate, while the feldspar phenocrysts are drawn out to ellipsoidal-shaped forms giving the rock a pseudofragmental appearance.

These intrusions have been metamorphosed under greenschist facies conditions. Col-

OGS 10536

Photo 16. *Porphyritic anorthositic gabbro intrusion from island along Northeast Arm of Sturgeon Lake. Plagioclase phenocrysts vary in size from 0.5 to 5 cm, the larger crystals have a subrounded, subhedral shape. The exposure is weakly foliated parallel to the hammer handle.*

our of the fresh surface varies from white-grey to green-grey while on the weathered surface they are light green, grey, and green, with local yellowish hues. The feldspar phenocrysts, which are of plagioclase composition, vary in size from 5 mm to 25 cm but generally average 2.5 cm or less. Their length to width ratio averages 1:5. They vary in colour from white to light green to light yellow to locally light pink in colour. The smaller phenocrysts are subhedral but as the size increases they become subrounded and anhedral in form. They are often fractured with actinolite or chlorite filling the fractures. They locally occur in clusters and rarely as glomeroporphyritic aggregates. A particular intrusion or area within the intrusion may contain anywhere from 5 to 60 percent feldspar phenocrysts. In thin section they show preserved normal zoning while invariably being altered to sericite and/or saussurite. In hand specimen the larger crystals show a well demarcated 1 to 5 mm margin or reaction zone possibly reflecting late-stage crystal-magma interaction. The matrix comprises actinolite and minor chlorite, fine-grained plagioclase and intersertal quartz, carbonate, sericite and epidote, and opaque iron oxides. Locally these rocks contain upwards of 3 to 5 percent finely disseminated magnetite.

Locally, irregular blob-like masses of phenocryst-rich gabbro are set in a fine-grained actinolitic matrix perhaps reflecting re-intrusion of the more mobile mafic component of the magma into the semi-solid feldspar crystal mush.

Several of these intrusions are zoned with respect to the size of the feldspar crystals. The zonation is both symmetrical, with the size increasing inwards from both borders, and asymmetrical, with size increasing from border to border. On the east shore of Trap Lake two narrow feldspar-porphyritic gabbro dikes intrude intermediate to felsic tuff. One dike

TABLE 7. MAJOR AND TRACE ELEMENT ANALYSES AND NORMATIVE MINERALOGY OF GABBRO AND DIORITE FROM THE SQUAW LAKE – STURGEON LAKE AREA.

Major Elements	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
SiO_2	49.20	44.6	45.40	50.10	52.80	49.50	48.00	51.30	50.30
Al_2O_3	14.30	24.20	19.30	13.50	13.20	14.50	14.20	13.70	13.50
Fe_2O_3	2.31	2.29	2.43	3.64	3.22	1.01	2.87	1.60	1.64
FeO	7.55	3.17	6.34	7.88	7.54	8.45	9.65	8.10	10.80
MgO	8.50	4.21	7.33	5.96	4.89	7.74	5.78	6.05	6.00
CaO	11.10	11.60	12.50	11.60	11.70	12.90	11.90	13.10	10.50
Na_2O	1.62	3.48	1.73	2.24	2.48	1.83	2.37	2.64	2.05
K_2O	0.17	0.17	0.02	0.19	0.05	0.07	0.14	0.14	0.17
TiO_2	0.91	0.74	0.82	1.70	0.98	0.94	1.54	0.96	1.86
P_2O_5	0.06	0.01	0.02	0.07	0.04	0.03	0.04	0.04	0.05
S	0.02	0.01	0.04	0.15	0.03	0.04	0.03	0.01	0.02
MnO	0.15	0.10	0.16	0.21	0.21	0.20	0.23	0.22	0.26
CO_2	0.25	0.20	0.17	0.53	0.38	0.17	0.14	0.17	0.15
H_2O^+	2.41	1.74	2.18	0.45	1.00	1.09	1.39	0.58	0.90
H_2O^-	0.16	0.65	0.58	0.60	0.50	0.53	0.54	0.53	0.66
Total	98.70	98.90	99.00	98.80	99.00	99.00	98.80	99.10	98.90
Specific Gravity	3.09	3.01	2.99	2.97	2.94	2.99	3.03	3.01	3.00
Trace Elements	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Ag	1	1	1	1	1	1	1	1	1
Ba	60	40	30	70	40	100	80	40	40
Be	1	1	1	1	1	1	1	1	1
Co	40	25	45	40	40	40	55	40	50
Cr	500	180	410	140	20	500	20	30	80
Cu	80	180	120	120	120	95	150	60	120
Ga	10	10	10	10	15	10	15	10	15
Li	15	5	8	10	3	4	6	2	4
Mo	1	1	1	1	1	1	1	1	1
Ni	170	85	160	70	35	120	65	60	70
Pb	55	30	55	70	30	55	60	45	35
Sc	60	20	20	45	35	30	30	40	50
Sn	1	3	250	3	40	9	15	8	30
Sr	200	60	40	60	10	20	60	20	20
V	300	90	90	250	150	200	200	150	150
Y	20	10	10	15	10	10	15	15	10
Zn	100	45	70	110	100	85	100	85	170
Zr	100	20	20	45	25	30	35	35	20

CONTINUED

TABLE 7. CONTINUED.

Normative Minerals	1	2	3	4	5	6	7	8	9
Quartz		0.000	0.000	5.463	8.361	0.452	0.408	1.289	4.430
Orthoclase		1.026	0.123	1.178	0.311	0.428	0.872	0.854	1.058
Albite		26.869	16.153	21.074	23.388	16.993	22.402	24.438	19.375
Anorthite		50.943	46.641	27.483	25.992	32.220	29.166	25.906	28.570
Diopside		5.152	10.499	16.072	17.200	17.703	15.463	20.107	11.494
Hedenbergite		1.082	3.683	7.810	10.571	9.323	10.719	12.570	9.253
Enstatite		0.000	8.537	8.205	5.580	13.249	9.068	7.167	11.690
Ferrosilite		0.000	2.994	3.546	3.429	6.977	6.286	4.480	9.412
Forsterite		6.963	5.444	0.000	0.000	0.000	0.000	0.000	0.000
Fayalite		1.462	1.909	0.000	0.000	0.000	0.000	0.000	0.000
Nepheline		3.008							
Magnetite		2.443	2.642	3.988	3.536	1.092	3.159	1.725	1.805
Ilmenite		1.052	1.188	2.482	1.434	1.354	2.259	1.379	2.728
Pyrrhotite		0.000	0.144	0.546	0.109	0.144	0.110	0.000	0.073
Apatite		0.000	0.044	0.154	0.088	0.065	0.088	0.086	0.110
Normative Plagioclase Composition (An content)		61.51	74.28	56.60	52.64	65.47	56.55	51.46	59.59
Differentiation Index		30.90	16.28	27.71	32.06	17.87	23.68	26.58	24.86
Colour Index		18.15	36.90	44.10	41.75	49.70	46.95	47.43	46.38

NOTES

Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto. Major elements in weight percent, trace elements in parts per million, normative minerals in molecular weight percent.

SAMPLES

	Sample No.	Latitude	Longitude	Lithology
1	T4234	50.0660	90.6011	Tremolite-rich quartz gabbro
2	T1200	50.0791	90.6119	Porphyritic and anorthositic chlorite gabbro
3	T2497-2	50.0677	90.5966	Hornblende gabbro
4	T2331-3	50.0513	90.5661	Hornblende gabbro
5	T4276-1B	50.0513	90.6111	Hornblende quartz gabbro
6	T3027-2	50.1005	90.6125	Hornblende quartz gabbro
7	T2577-1	50.1019	90.5536	Hornblende gabbro
8	T4567-1	50.1208	90.5816	Hornblende gabbro
9	1-6-5D-3	50.0313	90.7388	Hornblende gabbro

was 20 cm wide, the other had 11 cm of its width exposed. In the 20 cm wide dike, an 8 cm wide zone along its western border contained 2.5 to 6.5 cm phenocrysts, the remaining 13 cm comprised medium-grained equigranular gabbro. Several other bodies showing asymmetrical zoning are present, with the size invariably increasing from east to west.

As mentioned, several intrusions show symmetrical zonation which could possibly be explained by laminar flow of a semi-liquid crystal mush through a pipe-like conduit (Bhattacharji 1974). Origin of the asymmetrical zonation could be due to settling of the feldspar crystals after intrusion with the larger crystals coming to rest on the bottom (west side).

FELSIC INTRUSIVE ROCKS

Granitic Complexes

EASTERN GRANITIC COMPLEX

The Squaw Lake-Sturgeon Lake metavolcanic-metasedimentary sequence is bounded in the east by a batholithic granitic complex, the border phases of which underlie the eastern portion of the map-area. The foliation in the granitic rocks is essentially concordant with that in the adjacent metavolcanics and metasediments, and although intrusive relationships were observed between phases of the complex and the volcanic-sedimentary sequence, the contact appears to be in part fault controlled. No information was found, however, as to the sense and direction of movement, if any, along this fault zone.

Because only the border phases of this complex were mapped, little can be said of the main part of the granitic complex, though references to the granitic areas to the east do exist, the most recent being that of Sage *et al.* (1973). Exposure is abundant east of Vista Lake but diminishes rapidly to the north.

The Vista Lake, Flindt River, and Vanessa Lake Intrusions, although possibly petrogenetically related to the eastern batholithic complex, have been described separately as age relationships between these complexes and the batholithic complex are not definitely known and also because they are confined predominantly within the metavolcanic-metasedimentary sequence.

The granitic complex is composite in nature with several intrusive phases being recognized. The early phases of this complex comprise metamorphosed, well foliated to gneissic, biotite and hornblende-biotite granodiorite and trondhjemite. Subordinate phases are marked by the presence of microcline phenocrysts and the development of quartz lenticules. Intrusive into these early phases are massive to weakly foliated, trondhjemite, granodiorite, and locally quartz monzonite (not distinguished on legend), and pegmatoid and aplitoid phases.

One outcrop at the south end of Vista Lake is perhaps indicative of the complex history of intrusion of the border phases of this granitic complex. Here an early well foliated biotite granodiorite phase is interlayered with and appears to have been intruded by foliated biotite-hornblende granodiorite of the Vista Lake Intrusion. The biotite-hornblende granodiorite phase contains amphibolite inclusions possibly representative of incorporated fragments from the adjacent metavolcanic amphibolites. Both the biotite granodiorite, and biotite-hornblende granodiorite phases are intruded by feldspathic dikelets (mobilizates), and pegmatoid material. These are in turn cut by massive to weakly foliated chlorite-biotite trondhjemite that can be subdivided into quartz- and feldspar-rich zones or phases. The alteration of biotite to chlorite suggests that metasomatic adjustments occurred during the waning stages of intrusive activity.

In thin section the early biotite and hornblende-biotite granodiorite and trondhjemite are composed of the following mineral assemblage: plagioclase (oligoclase) + microcline and microcline perthite + quartz + biotite ± hornblende ± chlorite ± muscovite ± epidote ± carbonate + accessories including Fe-Ti oxide, pyrite, sphene, apatite, zircon, and hematite. The plagioclase occurs as subhedral locally moderately saussuritized or sericitized lath-shaped grains, commonly with oscillatory zoning. Microcline and microcline perthite occur as subhedral equant grains and locally as phenocrysts in the porphyritic phases. Antiperthite was observed in one thin section. Quartz occurs as subhedral to anhedral interstitial grains. In the quartz-lenticule granodiorite and trondhjemite the quartz occurs in subhedral, sutured lensoid aggregates comprising upwards of 30 to 40 percent of the rock. Formation of these quartz lenticules may have resulted from segregation accompanying cataclasis of these rocks. Green subhedral hornblende crystals accompany pale green to olive green to brown olive-green subhedral biotite grains. Pale green chlorite occasionally occurs as an alteration after biotite. Total mafic content is variable from 5 to 15

percent. Muscovite is locally a minor constituent of these rocks, and is common within the quartz-lenticule granodiorite and trondhjemite.

In the area east of Vista Lake several highly folded zones are present. The individual zones may be fault-bounded as there is an abrupt change from folded to non-folded areas. Specifically involved in the folding are the well foliated to gneissic, quartz-lenticule granodiorite and trondhjemite phases. Individual folds are tight with low amplitude, 1.3 cm to 0.6 m, and wavelength 1.3 cm to 0.5 m; there may be more than one generation of folds. In general the axial traces of the folds trend approximately north and dip moderately (50 ± 10 degrees) east. Fold axes were rarely measurable but trend generally north and plunge subvertically. The quartz lenticules predate folding as they are bent around the fold noses. No explanation for the folding mechanism and the spatial distribution of the folded zones is known. The later trondhjemite and granodiorite phases are not folded and cut across the fold structures.

The gneissic structure in the early granodiorite and trondhjemite gneisses is defined by alternating mafic- and quartz-feldspar-rich bands. The quartz-feldspar-rich bands are generally wider, 1 to 10 cm, than the mafic-rich bands which are 1 to 5 cm wide.

There are at least two phases or ages of pegmatoid material. In one outcrop east of Vista Lake an early granodiorite phase cut by a pegmatoid phase was faulted, with both phases disrupted. A later trondhjemite cuts the early granodiorite phase and is in turn intruded by a pegmatoid phase which transects the fault plane without disruption.

Non-penetrative cataclasis is evident in these rocks as faults on a macroscopic scale and fracturing of crystals on the microscopic scale. The presence of several faults is suspected because of abrupt changes in structural style of shear zones, as well as local concentrations of hematite which give the rock a reddish hue, and local concentration of epidote stringers. In thin section, microfracturing of feldspar crystals, kinking of twin planes in plagioclase crystals, intensely strain-mottled quartz, and the alteration of biotite to chlorite are all suggestive of cataclasis. As mentioned above both the formation of the quartz lenticules and the subsequent deformation of the quartz-lenticule granodiorite and trondhjemite may have occurred as a result of cataclasis.

Migmatite phases are intermittently present along the contact zone. They occur in agmatitic, raft, and layered arrays. It is the later granodiorite, trondhjemite, and locally quartz monzonite phases rather than the early granodiorite and trondhjemite phases that are intrusive into the volcanic-sedimentary sequence.

The granitic complex appears to have caused amphibolite facies metamorphism of the adjacent volcanic-sedimentary sequence. Because the amphibolite zone is of considerable extent it may be that the batholithic complex dips (west) at a rather moderate angle under the volcanic-sedimentary sequence.

WESTERN GRANITIC COMPLEX

The Squaw Lake-Sturgeon Lake metavolcanic-metasedimentary sequence is bounded in the northwest by the border phases of a batholithic complex that extends far beyond the map-area. The foliation in the granitic rocks is slightly discordant to that in the adjacent metavolcanic assemblage A, specifically north of King Bay where they are in fault contact. Along the east shore of the North Arm of Sturgeon Lake, contacts between the granitic and volcanic rocks vary from abrupt to transitional-xenolithic and migmatitic.

Mafic amphibolitic inclusions, while generally concentrated along the borders of this complex, are also common throughout the mapped portion of the batholith. This is in contrast to the eastern granitic complex where only rare mafic inclusions were observed, though Graham (1931, p. 43) mentioned that fragments of assumed mafic metavolcanics outcrop over a large area around Seseganaga Lake just east of the map-area.

The granitic complex appears to have caused amphibolite facies metamorphism of

the adjacent volcanic-sedimentary sequence, but in contrast to the eastern margin of the sequence the amphibolite zone is narrower and only intermittently developed indicating perhaps that the western granitic complex dips at a much steeper angle under the volcanic-sedimentary sequence than does the eastern granitic complex.

The western granitic complex is composite in nature with several intrusive phases. As with the eastern granitic complex, the apparent early phases are well-foliated to gneissic, biotite and amphibole-biotite granodiorite and trondhjemite. Considerable biotite-amphibole to amphibole granodiorite is also locally present. Subordinate phases are marked by the presence of plagioclase porphyroblasts. Intrusive into the early phases are small bosses and dikes of trondhjemite and porphyritic trondhjemite (see below), minor pegmatoid dikes and irregular masses, feldspathic mobilizates, and aplogranitoid phases. Migmatite of layered or agmatitic type is locally present along the contact zone.

Massive Trondhjemite, Porphyritic Trondhjemite

Massive to weakly foliated or sheared trondhjemite and porphyritic trondhjemite, locally variable to granodiorite, is intermittently present along the contact between the western granitic complex and the metavolcanic-metasedimentary belt; no equivalent phase is present within the eastern granitic complex. Although most of this phase is covered by the waters of the North Arm of Sturgeon Lake it appears to form several small discrete masses intrusive into both the mafic metavolcanics and the early granodiorite and trondhjemite phases.

One mass or pluton is exposed at the entrance to the North Arm of Sturgeon Lake. Its exposure comprises several dikes and larger irregular masses intrusive into the mafic metavolcanics along the east and west shores of the North Arm. The dikes are generally porphyritic while the larger irregular masses near the assumed central portion of this body are equigranular. Several dikes of similar composition along the shoreline of King Bay may be offshoots from this body. Graham (1931, p.44) described this intrusive mass and associated dikes:

> From an economic point of view, the most important of these younger bodies is the granodiorite boss in the North arm. This boss has intruded along the contact of the older gneiss and Keewatin formations; on the west, it grades imperceptibly into the older gneiss, remnants of which were found within the younger granite on the islands. Along its eastern border, the granodiorite has developed porphyritic phases. The Keewatin has undergone very little alteration along its contact with these porphyritic phases, and the contact is sharp. Where angular fragments of greenstone are included in the granite, as at the St. Anthony mine, little sign of alteration is evident. Under the microscope the granodiorite is seen to be composed of an acid plagioclase, orthoclase, microcline, quartz, brown biotite, green hornblende intergrown with the biotite shreds, small amounts of apatite, zircon, and magnetite.
>
> ....A large number of porphyry dikes accompanied the intrusion of the late granite bosses and are closely associated with the gold quartz veins. Several types are found in the vicinity of the granodiorite of the North arm. Coarse granoporphyry dikes have penetrated into pillow lavas along the south shore of King bay and on the peninsula north of the bay.

In thin section, these rocks are seen to be composed of plagioclase (oligoclase), quartz, microcline, hornblende, biotite, chlorite, and accessories including epidote, magnetite, sphene and zircon. Plagioclase forms subhedral to euhedral phenocrysts, generally moderately saussuritized and locally with oscillatory zoning. Quartz occurs as subhedral phenocrysts locally showing corroded lobate forms. Fine-grained subhedral quartz and plagioclase comprise a major portion of the groundmass. Microcline, in amounts of 5 to 10 percent, occurs as interstitial subhedral grains. The mafic minerals comprise green hornblende, generally partially altered to biotite, brown biotite, and biotite partially altered to chlorite. Mafic content averages 10 percent or less.

ST. ANTHONY PLUTON

The herein named St. Anthony Pluton appears to be another discrete body of granodiorite to trondhjemite that has intruded the mafic volcanic assemblage and has also possibly intruded the early biotite and hornblende-biotite granodiorite and trondhjemite phases. It has its main exposure on and west of the central portion of Couture Lake: the St. Anthony Mine is located within it (see "Can-Con Enterprises and Explorations Limited", under "Economic Geology").

The rocks of the pluton weather pink, white and brown and are generally pink to grey on the fresh surface. They are medium grained, equigranular to locally slightly porphyritic, and massive to locally weakly foliated. They are leucocratic, containing less than 10 percent biotite and in the vicinity of the mineralized zone containing the St. Anthony Mine they characteristically contain from 3 to less than 10 percent light green muscovite which locally appears to be an alteration of the biotite. In thin section the rocks are seen to be composed of quartz, sodic plagioclase, microcline, biotite, muscovite, and accessories including pyrite and carbonate. The quartz occurs interstitially in medium- to fine-grained anhedral, sutured aggregates. Subhedral, locally zoned, fresh to very slightly altered, lath-shaped plagioclase crystals locally have kinked twin planes suggestive of internal cataclasis. Microcline, generally in amounts of less than 5 percent, occurs as subhedral interstitial grains. Interstitial subhedral flakes of muscovite appear to be a local alteration of biotite. This altered phase has been extensively intruded by quartz veins, which locally form quartz stockworks.

Vista Lake, Flindt River, Vanessa Lake Intrusions

The Vista Lake, Flindt River, and Vanessa Lake plutons are a distinct series of synkinematic perthitic (actually antiperthitic) granodiorites locally variable to monzonite and quartz syenite. All three bodies occur as broad lenses to semi-concordant sheets in metavolcanics and metasediments of amphibolite rank. Structurally, the Vista Lake and Vanessa Lake bodies appear to have intruded or at least occupy recumbent, west-dipping, synclinal structures. The occurrence of antiperthite, apparently formed through piecemeal replacement of plagioclase by microcline, appears to vary across these bodies, as if potassic metasomatic solutions had moved selectively along certain zones, possibly accompanying the deformation that either produced (anatexis) or emplaced these bodies.

VISTA LAKE INTRUSION

Various portions of the Vista Lake Intrusion have been described previously by Trowell (1974c, 1976) and Rodgers (1964).

Within the present map-area, the Vista Lake Intrusion outcrops on the western shoreline of Vista Lake and the inland area to the west of the lake; outcrop exposure is low. The pluton is crescent-shaped, about 3.5 km wide at the centre and tapering to the north. It covers approximately 13 km^2. The pluton intruded high greenschist facies rank (biotite-garnet) metasediments. The pluton has itself metamorphosed the metasediments it intruded to hornblende hornfels facies rank, as shown by the mineralogical composition and development of a granoblastic-polygonal texture in the metasediments. Although the field relations are not clear it also appears to have intruded the eastern granitic complex.

In the southeast corner of the map-area an area of high magnetic response was detected (Barlow 1975a). The high magnetic response within the pluton may be caused by rafts of metasediments which contain substantial iron formation.

The rocks of the Vista Lake Intrusion are hornblende and biotite-hornblende granodiorite, locally variable to monzonite. The rocks weather pink to grey and are pink to grey on the fresh surface. Texturally they vary from medium-grained equigranular to coarse-

grained inequigranular porphyritic to locally augen-textured with ellipsoidal feldspar phenocrysts up to 2.5 cm in length.

The rocks of this complex contain the following mineral assemblage: quartz variable in amount from 5 to 20 percent but generally averaging greater than 10 percent, major plagioclase (oligoclase), minor to major microcline and microcline perthite, hornblende, biotite, chlorite, and accessories including Fe-Ti oxides, pyrite, sphene, apatite, carbonate, epidote, zircon and allanite.

Quartz occurs as subhedral to generally anhedral grains commonly showing marked strain extinction. Symplectic intergrowths with potassic feldspar are common. Plagioclase occurs both as subhedral phenocrysts and as remnant corroded grains enclosed in replacement antiperthitic intergrowths and enclosed in microcline and microcline perthite overgrowths. The plagioclase shows preserved oscillatory zoning but generally is moderately to extensively altered to saussurite. Microcline and microcline perthite occur as subhedral, medium to fine grains and in antiperthitic intergrowths, and overgrowths with the plagioclase.

The mafic content varies from 10 to 25 percent, averaging approximately 15 percent. The mafic minerals include hornblende, biotite, and chlorite. The hornblende occurs in subhedral grains and shows a light green to olive-green to blue-green pleochroism. Locally the outer fringe of these grains has a blue-green colour perhaps signifying a slightly more alkalic composition. The hornblende is locally partially replaced by biotite and/or chlorite. Locally it occurs in aggregate clots. Biotite occurs as discrete grains and after hornblende. Commonly the biotite is pleochroic in shades of light brown to brown (slightly reddish) and locally yellow-green to brownish olive-green. Chlorite occurs in felted fibrous aggregates apparently after both hornblende and biotite. Hornblende generally occurs in excess of biotite.

The biotite, especially the green variety, contains abundant sphene inclusions. Fe-Ti oxides occur as subhedral grains locally with abundant apatite grains. Sphene and apatite are ubiquitous in amounts of 1 to 2 percent. They occur interstitially as fine subhedral to euhedral grains. Subhedral fine allanite grains showing partial (metamict) alteration to an amorphous isotropic substance, are present in amounts of 1 to 2 percent. Hematite is locally present, apparently after magnetite, in those rocks which show effects of cataclasis.

Several grab samples were slabbed and stained to determine the potassic feldspar content. The ratio of potassic feldspar to total feldspar varies from 1.5:5.5 to 1:2.

Pegmatoid phases of approximate syenite composition comprising mainly potassic feldspar and hornblende are locally intrusive into the granodioritic phases, as are dikes of more leucocratic quartz monzonite, aplite, and feldspathic mobilizates.

Feldspar augens are generally aligned parallel to the foliation defined by the subparallel alignment of the mafic minerals. The antiperthitic intergrowths and/or potassic feldspar overgrowths are perhaps indicative of extensive feldspar metasomatism though their actual distribution and extent are not known.

The subparallel alignment of the mafic minerals and their concentration into mafic-rich bands or zones define a planar foliation locally approaching a gneissic structure. Internal cataclasis is shown by fractured and kinked (twin planes) feldspar grains and local comminution of the matrix minerals.

FLINDT RIVER INTRUSION

The Flindt River Intrusion outcrops on the shoreline of the wide southern portion of the Flindt River. It has an irregular roughly lensoid shape and may actually comprise a series of dikes (apophyses from the Vista Lake Intrusion?) rather than a discrete intrusive mass. Its interpreted extent is 1060 m long and 60 m wide. It has intruded metavolcanics and metasediments and locally contains xenoliths of amphibolite facies rank mafic metavolcanics

and laminated metasediments. Its composition is dominantly granodiorite variable locally to quartz monzonite or monzonite.

Texturally, the rocks of the intrusion are medium-grained, equigranular to inequigranular porphyritic, to locally augen-textured. Its mineralogical composition comprises 10 percent or more anhedral quartz, major plagioclase as medium- to coarse-grained subhedral phenocrysts with corroded ends and averaging 8 mm in length, and in antiperthitic intergrowths with potassic feldspar, anhedral to subhedral interstitial microcline, major subhedral inclusion-rich hornblende, minor pale brown to brown pleochroic biotite, and chlorite as ragged felted aggregates moulded around the hornblende and locally concentrated in thin discontinuous streaks. Accessories include Fe-Ti oxides, pyrite, epidote, carbonate, apatite and sphene. The chlorite is pleochroic in shades of yellow to pale green. The carbonate locally occurs in thin discontinuous stringers. Where potassic feldspar content approaches 35 to 40 percent, the intrusion has a quartz monzonitic composition.

Quartz monzonitic veinlets and dikelets locally cut both the granodiorite-quartz monzonite of the pluton and the supracrustal rocks it intrudes. The mineralogical composition and textures are very similar to those seen in the Vista Lake pluton.

VANESSA LAKE INTRUSION

The Vanessa Lake Intrusion outcrops on the islands and shoreline of Vanessa Lake. It has an elongated lensoid, sill-like shape tapering both to the north and south. It is 8 km long and averages 0.6 km wide: its areal extent is approximately 5 km^2.

This body has intruded an assemblage of mafic metavolcanics and metasediments of amphibolite facies rank. It is an essentially concordant intrusion parallel to the foliation of the country rocks. Only a few dikes and veins associated with this body cut the country rocks and, except for the development of minor plagioclase porphyroblasts and the local presence of a folded agmatite zone along its western border, the country rocks have been relatively unaltered by its intrusion.

Compositionally the intrusion varies from granodiorite to quartz monzonite to locally monzonite. Texturally, the rocks are medium-grained equigranular, to medium- to coarse-grained inequigranular porphyritic, to locally augen-textured. The largest feldspar phenocrysts or augens appear to be associated with the central phases of this body. The rocks of this complex are pink to pink-grey on both the weathered and fresh surface. The rocks are foliated to locally gneissic. The foliation is more strongly developed than in either the Vista Lake or Flindt River Intrusions.

Table 8 gives the major and trace element analyses and normative composition (after the method of Irvine and Baragar 1971) of one grab sample collected by the author from this body.

The rocks of this intrusion contain the following mineral assemblage: quartz quite variable in amount but generally averaging 10 percent; major plagioclase, generally oligoclase composition where measurable; minor to major microcline and microcline perthite; major hornblende, biotite, chlorite; and accessories including magnetite, pyrite, hematite, sphene, zircon, epidote and apatite.

Quartz occurs as fine anhedral to subhedral grains, and locally as equigranular-polygonal aggregates in the more strongly foliated rocks. Plagioclase occurs as subhedral phenocrysts, 5 to 15 mm in size, locally showing preserved oscillatory zoning but also generally altered to saussurite, and as fine grains overgrown by microcline and microcline perthite. Microcline and microcline perthite occur as fine to medium subhedral grains and locally as medium-grained phenocrysts. Hornblende, pleochroic in shades of light green to olive green to dark blue-green, occurs as subhedral grains, commonly lath-shaped and locally partially altered or replaced by biotite. Biotite, pleochroic in shades of light green-brown to dark olive-green-brown, is present as fine to medium subhedral grains locally

TABLE 8. MAJOR AND TRACE ELEMENT ANALYSES AND NORMATIVE COMPOSITION O SAMPLE T2619-1 FROM THE VANESSA LAKE INTRUSION.

Major Elements		Trace Elements		Normative Minerals	
SiO_2	66.30	Ag	<1	Quartz	14.404
Al_2O_3	16.90	Ba	820	Orthoclase	20.745
Fe_2O_3	1.46	Be	1	Albite	43.926
FeO	1.30	Co	9	Anorthite	13.625
MgO	1.21	Cr	50	Enstatite	2.419
CaO	3.49	Cu	6	Ferrosilite	0.471
Na_2O	4.91	Ga	10	Diopside	1.820
K_2O	3.52	Li	10	Hedenbergite	0.354
TiO_2	0.28	Mo	1	Magnetite	1.521
P_2O_5	0.14	Ni	25	Ilmenite	0.389
S	0.01	Pb	50	Pyrrhotite	0.035
MnO	0.05	Sc	<10	Apatite	0.292
CO_2	0.13	Sn	<1		
H_2O^+	0.32	Sr	700	Normative Plagioclase	
H_2O^-	0.27	V	50	Composition	$An_{23.6}$
		Y	<10	Normative Colour Index	6.97
Total	100.30	Zn	55		
		Zr	100	Differentiation Index	79.08
Specific Gravity	2.70				

NOTES

Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto. Major elements in weight percent, trace elements in parts per million, normative composition in molecular weight percent.

Sample Location: Latitude 50.11667, Longitude 90.50000.

showing partial alteration to pale green chlorite. Mafic content is highly variable from 10 t 30 percent but generally averages approximately 15 percent.

Along the western border of this pluton local migmatitic zones are developed at th contact with amphibolitized mafic volcanic rocks. Locally the intrusive rocks appear t have chilled against the country rocks, being fine grained and having a leucocratic tro dhjemitic composition.

At both ends, the intrusion is transgressive to the country rocks. At the north end it is i agmatitic contact with the mafic metavolcanic amphibolites. At the south end 2.5 to 30 c veins of a porphyritic granodiorite phase of the pluton cut the country rocks.

INTERMEDIATE AND ALKALIC INTRUSIVE ROCKS

According to Sorenson's classification (1974, p.23), both the Sturgeon Narrows an Squaw Lake Alkalic Complexes are miaskitic in composition; that is the number of Na an K atoms are less than the number of Al atoms. As yet they do not appear to fit into any re gional pattern with respect to the distribution of the other alkalic complexes of the Cana dian Shield (Barker 1974). If, in the future, the two complexes are radiometrically date they could probably be placed in a spatial and temporal framework.

Sturgeon Narrows Alkalic Complex

Most of the Sturgeon Narrows Alkalic Complex lies within the Quest Lake map-area, described previously by the author (Trowell 1976). The rock-types and mineralogy are described in detail in the Quest Lake report, and the reader should refer to that publication for additional information. The following descriptions are abstracted from that report, with additions and changes as necessitated by new information.

An alkalic plutonic complex, the Sturgeon Narrows Alkalic Complex outcrops with moderate to marked positive relief along and east of Sturgeon Narrows. Actual outcrop exposure is however generally poor. The complex has a tadpole shape being elongated in a northeasterly direction and tapering rather abruptly at its southwest end. It is 13.7 km long and varies in width from 1.3 km to 4.5 km. While the rocks of this complex are highly variable in appearance they can be assigned to four broad groupings on the basis of mineralogy, texture, and spatial distribution. These are: outer syenite (Photo 17); inner syenite; inner leucosyenite which locally appears to intrude the inner syenites; and the eastern syenogabbro-syenodiorite zone. These can be classed into two main groups: feldspathoidal, with foids and essential feldspar; and feldspathic, without foids. The principal foid, nepheline, which was apparently originally present both in the inner and outer syenites, has suffered variable alteration; as a result, the two-fold grouping is only approximate.

A southwest plunge and a slight westerly dip of this complex could explain its shape, the lack of an outer coarse-grained zone around its northern margin, and the presence of the syenogabbro-syenodiorite zone comprising its northern margin.

The alkalic complex exhibits rapid changes from one phase to the next both in mineralogy and texture, and various secondary alterations have locally effectively masked the original mineralogy of these rocks. While outcrop exposure is locally abundant along the shore and islands of Sturgeon Narrows it is quite sparse in the eastern interior portion of the complex due to a thick cover of overburden and vegetation.

The contacts of the complex are approximately concordant to the foliation trends of its wallrocks although at the north end of Sturgeon Narrows its western contact is slightly discordant or is a fault contact. The wallrocks are greenschist facies metavolcanics, metasediments, and minor mafic intrusive rocks.

The wallrocks locally show the effects of metasomatism, i.e. fenitization, due to mineralogical transformation caused by solutions generated within the alkalic system. Areas within the wallrocks where fenitization has occurred are locally detectable in outcrop by the development of pink or purple hues, by local 'bleached' areas, by veinlets and stringers of pink alkali feldspar, by local areas of pervasive feldspathization and by the development of pyroxene + feldspar patches along joint-planes. In general, though, the wallrocks have been weakly fenitized, involving only minor modifications of the original mineral assemblages.

The author hypothesized (Trowell 1976) that this complex intruded along a fault zone originally initiated and localized in a zone of metasediments which underlay and is still partially preserved along Sturgeon Narrows. While intrusion was initiated along a discordant structural zone, final emplacement, at least in the area of its eastern contact with its wallrocks, tended to approximately conform to the regional structural (fold) pattern. Interpreted faults on the west shore of Sturgeon Narrows are suggestive of structural emplacement of the alkalic complex within a graben-like or 'crustal arching' structure. The eastern shoreline of Sturgeon Narrows forms several sharp lineaments that, along with the physiographic expression of the Sturgeon Narrows Alkalic Complex, indicate the possibility that the east shore is also, at least in part, structurally or fault controlled.

Penecontemporaneous (with intrusion) or later fracturing of this complex is suggested by cataclastic effects observed in thin section in the rocks of this complex and by breccia zones in the southeastern portion of this complex.

The presence of carbonate dikes cutting the metavolcanics and metasediments along

OGS 10537

Photo 17. *Mafic inclusions in outer syenite of Sturgeon Narrows Alkalic Complex. From south shore of East Bay, Sturgeon Lake.*

the narrows and the local presence of carbonatized areas within the complex itself have led to speculation that this body might have associated intrusive carbonatite phases. Trace element and mineral identification of the carbonate from these dikes indicate that the carbonate is primarily low-iron dolomite and that it does not contain the trace element suite — specifically with regard to barium and strontium content — characteristic of carbonatites (Heinrich 1966). These dikes appear to fill tension fractures possibly formed as a result of movement along the postulated fault zone. The coarse pegmatitic texture, lack of extensive fenite zone, low grade metamorphism of its wallrocks, all would suggest that this complex has intruded the supracrustal rocks at a relatively high level in contrast to the majority of carbonatite complexes. The presence of probable miarolitic cavities would suggest a hypabyssal origin. As well, the associated rock suite is not characteristic of carbonatite complexes; specifically an ijolitic rock suite (Heinrich 1966) is absent.

This complex locally exhibits flow banding (lamination) and compositional and textural layering. The large, generally perthitic, potassic feldspar grains of the outer coarse-grained inequigranular syenite locally define a trachytoidal texture (strictly speaking, a lineation). This alignment of the feldspar grains has been interpreted by the author as an expression of primary flow lamination, which parallels the contact of this complex.

A non-penetrative cataclastic foliation has locally developed. There appear to be two types of deformation: (1) microbreccia, observed along Sturgeon Narrows, probably formed as a result of post-consolidation movement along the postulated fault zone; and (2) in the eastern and northern parts of the complex, protoclastic fractures, observed only in thin section, appear to have formed by cataclasis due to late intrusive movements within the phases of the complex before complete crystallization.

Most of the rocks of this complex, with local exceptions apparently due to alteration ef-

fects, are undersaturated with respect to silica and contain normative (and modal) nepheline (Table 9). The normative compositions are also characterized by consistently substantial amounts of sodic plagioclase and generally less than 10 percent total mafic minerals.

FENITIZATION

The most intense area (though even here only moderately developed) of fenitization occurs on the middle island of Sturgeon Narrows, the shore west of this island and on Coveney Island, while the most widespread effects of fenitization were observed along the eastern contact of the complex with mafic metavolcanics and associated mafic intrusive rocks.

On the middle island of Sturgeon Narrows (south of the Squaw Lake-Sturgeon Lake map-area) and the shore to the west of it, metasediments, including volcanogenic conglomerate and wacke, have been extensively altered. On the west shore, conglomerate has been transformed to a pink fine-grained feldspathic rock, the outline of clasts only being visible on the weathered surface. On the island, perthite syenite porphyry and gieseckite (pseudomorphed nepheline?) perthite syenite porphyry intruded the metasediments; some of the porphyries might be porphyritized metasediments. The wackes are locally characterized by up to 25 percent replacement perthite.

Along the eastern contact of the complex the effects of fenitization on the medium-grained gabbroic country rocks include the development of blue-green (alkalic) amphibole rimming the original amphibole of these rocks, and the formation of clot-like aggregates of colourless (tremolitic) amphibole, minor pyroxene, garnet, and sphene. Even here, however, fenitization with respect to that associated with other alkalic complexes (Heinrich 1966) involves only minor metasomatism of the wall rocks.

Fenitization is also apparent on Seaton Island where the alkalic complex has intruded metavolcanic, mafic intrusive and metasedimentary rocks. Apparently no new minerals were developed and except for the development of a pink cast the effects were minor. Fenitization is apparent on the north shore of Coveney Island where metasediments have been extensively feldspathized and also locally show the development of a deep mauve pleochroic amphibole (variety riebeckite?).

Squaw Lake Alkalic Complex

A second alkalic plutonic complex, the Squaw Lake Alkalic Complex, outcrops on the islands and shoreline of Squaw Lake. Outcrop exposure is generally poor. The complex has an elliptical shape, 4.4 km long and 2.5 km wide; its areal extent is approximately 10 km^2.

Only brief mention of this complex has appeared in the literature (Gledhill 1925, p.26; Graham 1931, p.44) and no detailed descriptions of it exist. The author suggests that this complex is possibly comagmatic (cogenetic) to, and was contemporaneously intruded with, the Sturgeon Narrows Alkalic Complex.

This complex has forcibly intruded a supracrustal assemblage of greenschist facies mafic to intermediate and felsic to intermediate metavolcanics and associated mafic intrusive rocks. The foliation of the supracrustal assemblage deflects away from and bends around this intrusive complex. Intrusion of the complex was therefore probably synkinematic to post-kinematic with respect to the regional deformation of this area. The resultant stress attendant upon intrusion of this complex has been released both by warping of the supracrustal host rocks and by faulting.

There appear to be two petrogenetic lineages represented within this complex: an earlier quartz-bearing monzonite-syenomonzonite, and a later nepheline-normative syenomonzonite. Various quartz-bearing monzonitic and syenomonzonitic phases comprise the southern half of this complex, while various nepheline-normative phases comprise the northern half. Along the western margin rafted blocks of quartz-bearing monzonite and

TABLE 9. MAJOR AND TRACE ELEMENT ANALYSES AND NORMATIVE COMPOSITION OF SAMPLES FROM THE STURGEON NARROWS ALKALIC COMPLEX.

Major Elements	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
SiO_2	60.30	57.80	56.80	66.60	54.80	59.40	60.90	53.70
Al_2O_3	22.30	15.90	19.00	16.10	19.00	16.40	18.10	16.50
Fe_2O_3	2.27	5.32	3.19	2.13	3.41	3.05	2.82	2.27
FeO	0.28	0.63	0.77	1.32	1.95	1.39	2.09	4.72
MgO	0.42	0.08	0.40	0.85	1.52	1.12	2.29	4.90
CaO	1.16	6.63	1.86	2.01	3.09	3.24	2.19	7.51
Na_2O	4.07	6.80	8.25	5.26	8.64	6.62	6.07	5.50
K_2O	8.28	5.09	7.41	4.53	5.75	4.50	5.19	2.30
H_2O^+	.80	0.62	1.63	0.63	1.39	0.54	0.53	0.86
H_2O^-	0.04	0.13	0.11	0.12	0.11	0.11	0.02	0.10
CO_2	0.70	0.28	0.96	1.25	0.72	3.52	0.16	0.81
TiO_2	0.30	0.75	0.38	0.38	0.41	0.57	0.52	0.75
P_2O_5	0.02	0.10	0.04	0.09	0.07	0.29	0.22	0.46
S	0.05	0.30	0.15	0.01	0.30	0.46	0.02	0.02
MnO	0.07	0.10	0.11	0.07	0.16	0.11	0.08	0.14
Total	101.06	100.53	100.06	101.35	101.32	101.32	100.30	100.54
Specific Gravity	2.66	2.68	2.56	2.69	2.61	2.55	2.65	2.86
Trace Elements	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Ba	500	800	600	1000	1500	1500	1000	1000
Co	4	4	7	4	9	10	10	25
Cr	15	nd	nd	20	300	70	20	150
Cu	20	7	9	9	10	30	20	35
Ga	15	5	15	15	20	10	20	15
Li	nd	nd	nd	nd	100	nd	nd	50
Ni	20	10	15	20	30	50	20	100
Pb	10	15	20	10	30	15	15	nd
Sb	nd	nd	nd	nd	nd	nd	nd	1
Sc	nd	nd	nd	nd	20	nd	nd	20
Sr	250	1000	1000	300	400	350	1000	1200
V	50	200	30	40	50	40	150	140
Y	nd	150	nd	nd	nd	20	20	25
Zn	50	40	90	60	150	110	100	100
Zr	150	200	150	150	250	250	300	0
Be	5	3	3	3	5	nd	5	3
Rb	200	90	140	80	200	90	90	40

CONTINUED

TABLE 9. CONTINUED.

Normative Minerals	1	2	3	4	5	6	7	8
Quartz	1.692	—	—	12.757	—	—	—	—
Corundum	4.934	—	—	—	—	—	—	—
Orthoclase	48.394	29.745	42.637	26.753	32.747	26.721	29.873	13.488
Albite	36.110	39.099	24.817	47.155	18.059	54.461	53.086	38.365
Anorthite	5.559	—	—	6.922	—	1.742	6.621	13.427
Nepheline	—	10.145	24.817	—	29.436	2.022	—	6.357
Acmite	—	3.450	8.652	—	6.060	—	—	—
Diopside	—	0.436	2.149	1.861	8.081	6.209	1.855	12.101
Hedenbergite	—	—	—	0.098	2.651	—	0.187	4.328
Enstatite	1.146	—	1.120	1.413	—	—	0.145	—
Ferrosilite	—	—	—	0.074	—	—	0.015	—
Forsterite	—	—	—	—	—	—	3.810	5.522
Fayalite	—	—	—	—	—	—	0.385	1.975
Wollastonite	—	12.525	1.855	—	0.363	1.893	—	—
Magnetite	0.058	—	—	2.224	1.160	1.104	2.869	2.353
Ilmenite	0.413	0.605	0.515	0.529	0.550	0.797	0.705	1.036
Pyrite	0.129	0.772	0.380	0.026	0.752	1.203	0.051	—
Hematite	1.525	2.801	—	—	—	1.398	—	—
Apatite	0.041	0.207	0.081	0.188	0.141	0.610	0.448	0.955
Sodium Silicate	—	—	0.895	—	—	—	—	—
Rutile	—	0.214	—	—	—	—	—	—
Chromite	—	—	—	—	—	—	—	0.024
Plagioclase Composition	$An_{13.340}$	An_0	An_0	$An_{12.801}$	An_0	$An_{3.001}$	$An_{11.098}$	$An_{25.925}$

NOTES

Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto. Major elements in weight percent, trace elements in parts per million, normative composition in molecular weight percent.
Ce, La, Nd, and Nb were tested for but were not detected.
nd = not detected.

SAMPLES (Samples 1-7 are from the Quest Lake map-area, Trowell 1976)

	Sample No.	Latitude	Longitude
1.	1-20-7	49.93900	91.86500
2.	3-38-4	49.99400	90.71200
3.	PL-1A	49.96100	90.81500
4.	1-24-18	49.96400	90.81500
5.	2-35-13	49.80100	90.75700
6.	1-22-2	49.94400	90.85800
7.	1-25-1	49.94000	90.85100
8.	1-32-2C-3	50.00910	90.66720

syenomonzonite are suspended in an alkalic syenite matrix. In turn, the quartz-bearing monzonite and syenomonzonite phases also contain subangular mafic inclusions possibly representing fragments of the mafic metavolcanic or intrusive country rocks which they intrude.

The wallrocks only locally show the effects of metasomatism or fenitization. In the felsic to intermediate metavolcanics along the northwestern border of the complex, the effects of fenitization are characterized by a pink (feldspathization) or green (chloritization) cast on the outcrop surfaces that lie within 60 m of the contact. The mafic to intermediate metavolcanics and mafic intrusive rocks show no apparent signs of widespread fenitization. Chlor-

ite is common in them under the prevailing metamorphic grade although the hybrid contact zones with the alkalic complex do show local metasomatic/metamorphic effects such as the development of potassic feldspar porphyroblasts.

Fracturing of the complex, penecontemporaneous with intrusion, is suggested by cataclastic effects observed in thin section. These include: comminution of feldspar margins producing large brecciated feldspar grains set in a fine grained dust; kinking and warping of twin planes in both biotite and feldspar; and internal fracturing of feldspar grains and their subsequent cementing with fine-grained albite and cancrinite. The deformation may in part be protoclastic (Higgins 1971, p.13) in nature whereby deformation occurred prior to complete solidification of the magmatic rocks of this complex. This is evidenced by the partial fracturing of the feldspar grains that were subsequently cemented by cancrinite veinlets representing crystallization of the still liquid residue. The cataclastic effects noted within this complex might be cryptovolcanic in origin, that is the cataclasis may have been a result of dynamic or shock metamorphism in which the strain rate was very high.

The local high aeromagnetic responses on Map 1118G (ODM-GSC 1961) recorded over the general area of the western margin of this complex could be due to local, covered, magnetite concentrations and/or to mafic intrusive rocks; the complex may dip westward under the metavolcanics producing a hybrid magnetic response. The magnetite is concentrated towards the margin of the complex.

The aeromagnetic response has an oval configuration that extends beyond the borders of the complex. It is asymmetrical in that aeromagnetic highs occur over the western and southern margins of this body. An aeromagnetic low is present over the approximate centre of this body.

The Squaw Lake Alkalic Complex is believed to have intruded into a high crustal level for the following reasons: (1) presence of apparent miarolitic cavities, (2) coarseness of grains, specifically feldspar, (3) narrow to nonexistent fenite zone, and (4) greenschist facies metamorphic grade of the country rock (Heinrich 1966). It is feasible that this complex broke through to the surface, and would have provided high strain rate for protoclastic (cryptovolcanic) deformation possibly evidenced by kinked feldspar and biotite though no extrusive equivalents were found.

Petrology

On the weathered surface, rocks of the complex are white to grey to pink to red, with various hues of orange, green, and yellow. The fresh surfaces are the same colours though of lighter shades. Texturally, these rocks are inequigranular to locally porphyritic and are medium- to coarse-grained to locally pegmatitic. The quartz-bearing phases are generally equigranular and medium grained. They are foliated to weakly gneissic structured.

The rocks of the complex exhibit flow lamination and local compositional and textural layering. The large perthitic feldspar grains of the outer coarse-grained inequigranular alkalic syenomonzonite locally define a trachytoidal texture in which the long dimensions of the feldspar grains are subparallel. This alignment of feldspar grains has been interpreted as an expression of primary flow lamination. A flow lineation marked by the alignment of aegerine-augite needles was also locally observed. These lineations roughly parallel the contact of this body though there are local variations.

The Squaw Lake Alkalic Complex has been subdivided into two broad groupings of rock-types: (1) alkalic syenite and syenomonzonite, and (2) quartz-bearing syenite, syenomonzonite and monzonite. The alkalic phase comprises the northern half of the complex; it is coarse-grained to pegmatitic, inequigranular, locally trachytoidal structured, and concentrically zoned. The quartz-bearing phase comprises the southern portion of the complex; it is medium-grained, equigranular, foliated, and is intruded by the alkalic phase. The alkalic grouping is invariably nepheline normative (Table 10). The normative calculation is,

however, only a general indication of bulk composition, because the complex has undergone intense alteration.

The alkalic portion of the complex is concentrically zoned with respect to silica and nepheline content; both increase towards the centre of the body with the highest silica values in the east-central portion. While the trachytoidal structure, chemical composition, and mineralogical assemblages suggest a zoned complex, it was not possible in this limited study to map discrete units of the complex. The alkalic phase is characterized by heterogeneity and mixing of various textural and mineralogical phases, which suggests that it was not in equilibrium. The various phases of the complex have probably had different crystallization and alteration histories.

A hybrid border phase produced by reaction between the quartz-bearing monzonite phase of the complex and the enclosing intermediate metavolcanics is exposed along the west-central and southern margins of this complex. The zone is composed of inclusion syenite consisting of mafic metavolcanic xenoliths set in a garnet-bearing (quartz) monzonite-granodiorite matrix, and a layered zone consisting of alternating layers of amphibole trondhjemite gneiss and biotite-garnet trondhjemite gneiss. In thin section the garnet-bearing trondhjemite gneiss consists of anhedral quartz and garnet phenocrysts set in a granoblastic-polygonal groundmass of plagioclase, biotite, amphibole, chlorite, zoisite and magnetite. Pink leucocratic monzonite and syenomonzonite dikes cut all the units within this hybrid zone.

A 1.2 m wide minette-type (biotitic) lamprophyre dike discordantly intrudes the felsic to intermediate metavolcanics along the western margin of this complex. It contains subrounded, 10 to 20 cm diameter inclusions of medium-grained equigranular metagabbro and medium-grained quartz-feldspar (trondhjemite) porphyry, possibly a hypabyssal equivalent of the felsic metavolcanics.

Along the western margin of this complex, magnetite veinlets cut natrolite-biotite-perthite syenomonzonite. These veinlets are approximately 2.5 cm wide, dip at 60 degrees with variable strike and were traceable over a metre or more. A sample from one of these veinlets, composed of magnetite set in a minor gangue of biotite, natrolite, analcite, and limonitic powder was examined by the Geoscience Laboratories, Ontario Geological Survey. The analysis showed that the magnetite contains minor titanium, and that no detectable quantities of rare earths, thorium, uranium or phosphorous are present. Magnetite also occurs throughout the alkalic portion of this complex in several forms: as fine disseminated grains in amounts of 1 to 2 percent; as large, 5 by 5 cm clots; and as disseminated blebs accompanying large biotite (balls) clots in pegmatoid syenite.

Mineralogy

Alkalic Phase. The foids present within this complex are nepheline, cancrinite, and sodalite; cancrinite is the most common and most abundant. The nepheline occurs as fine interstitial subhedral grains and in veinlets. The abundance of zeolites, which may be pseudomorphic aggregates after nepheline or other foids, suggests that nepheline was formerly more abundant.

Cancrinite occurs as fine yellow grains in amounts from 5 to more than 30 percent. It forms interlocking aggregates interstitial to feldspar. Locally the cancrinite occurs in veinlets and as apparent replacement of the feldspar suggesting that it was a late-forming mineral.

Sodalite was identified in one sample and confirmed by X-ray analysis (Geoscience Laboratories, Ontario Geological Survey).

The zeolites present within this complex are natrolite, analcime, and stilbite. Natrolite gives these rocks a pink to red colour in hand specimen. It occurs as fine-grained, locally fibrous, interstitial aggregates. Locally it is accompanied by carbonate and muscovite.

TABLE 10. MAJOR AND TRACE ELEMENT ANALYSES AND NORMATIVE MINERALOGY OF SAMPLES FROM THE SQUAW LAKE ALKALIC COMPLEX.

Major Elements	1	2	3	4	5	6	7	8	9	10	11
SiO_2	52.80	56.30	56.50	56.80	57.10	60.00	62.10	63.10	63.20	65.30	65.80
Al_2O_3	18.20	21.90	15.40	18.70	18.50	18.50	18.20	20.40	18.90	19.00	18.00
Fe_2O_3	2.24	1.02	3.08	1.49	5.00	1.33	2.00	0.33	2.07	0.72	1.15
FeO	3.16	1.78	2.11	1.54	3.00	1.30	1.54	1.05	1.22	0.24	0.32
MgO	1.13	0.18	1.34	0.20	0.46	0.30	0.79	0.44	0.18	0.10	0.12
CaO	4.68	1.04	6.47	3.80	0.14	2.18	2.59	1.90	0.18	0.89	1.03
Na_2O	5.51	8.42	5.65	7.77	4.21	6.25	7.07	6.80	6.85	6.36	6.80
K_2O	6.41	6.56	5.12	4.73	8.01	6.28	3.26	5.14	5.74	7.34	6.17
H_2O^+	1.24	0.93	1.26	0.75	0.56	1.23	0.41	0.18	0.18	0.11	0.00
H_2O^-	0.01	0.26	0.08	0.19	0.27	0.42	0.32	0.32	0.02	0.11	0.00
CO_2	2.72	0.60	1.05	2.55	0.15	0.56	0.13	0.60	0.15	0.15	0.17
TiO_2	0.53	0.38	0.46	0.46	0.77	0.45	0.54	0.18	0.24	0.44	0.18
P_2O_5	0.50	0.03	0.72	0.14	0.02	0.06	0.19	0.20	0.02	0.23	0.39
S	0.16	0.21	0.14	0.23	0.03	0.04	0.02	0.05	0.02	0.04	0.04
MnO	0.12	0.04	0.12	0.05	0.05	0.03	0.05	0.05	0.04	0.03	0.03
Total	99.4	99.6	99.5	99.4	98.3	98.9	99.2	100.7	100.0	100.9	100.2
Specific Gravity	2.66	2.53	2.75	2.60	2.58	2.59	2.66	2.56	2.65	2.57	2.58

CONTINUED

TABLE 10. CONTINUED.

Trace Elements	1	2	3	4	5	6	7	8	9	10	11
Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ba	1650	600	2300	460	1500	780	650	710	180	550	540
Be	<1	<1	<1	<1	<1	<1	<3	<1	<1	<1	<1
Co	8	<5	10	<5	6	<5	8	8	<5	<5	<5
Cr	6	<5	<5	<5	<5	<5	15	50	<5	<5	<5
Cu	6	<5	10	6	8	8	9	15	15	<5	7
Ga	10	10	10	10	10	10	20	10	20	10	10
Li	20	25	10	9	15	15	10	15	15	6	10
Mo	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ni	5	<5	<5	<5	<5	<5	15	25	<5	<5	<5
Pb	65	<10	<10	<10	<10	<10	30	<10	30	<10	<10
Sc	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10
Sn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sr	2000	400	1000	1000	200	600	500	500	100	300	400
V	60	40	70	50	70	40	40	50	30	30	30
Y	20	<10	10	10	<10	<10	20	<10	<10	<10	<10
Zn	90	80	90	60	150	55	100	50	95	25	35
Zr	<10	100	100	<10	10	100	500	100	200	<10	90
Rb	80	120	60	60	150	110	40	60	146	100	110

SAMPLES

Sample No.	Latitude	Longitude
1. T275-1	50.05833	90.55667
2. T425-2	50.08333	90.54167
3. T293-3	50.07500	90.54167
4. T2337-1	50.08333	90.54167
5. T2432-1	50.08333	90.56667
6. T2435-1	50.07500	90.57500
7. T2436-1	50.05832	90.57500
8. T266-1	50.06667	90.58333
9. T2430-1	50.07500	90.57500
10. T265-3	50.06667	90.55833
11. T2406-1	50.06667	90.56667

CONTINUED

TABLE 10. CONTINUED.

Normative Minerals	1	2	3	4	5	6	7	8	9	10	11
Apatite	1.073	0.061	1.529	0.294	—	0.126	0.395	0.407	0.041	0.081	0.082
Pyrrhotite	0.569	0.708	0.493	0.801	0.107	0.140	0.069	0.169	0.069	0.101	0.101
Ilmenite	0.757	0.514	0.650	0.643	1.102	0.631	0.746	0.244	0.330	0.275	0.397
Orthoclase	38.846	37.674	30.706	28.055	48.676	37.373	19.131	29.530	33.506	42.087	35.532
Albite	21.523	28.312	41.298	44.057	38.836	46.807	62.981	58.716	60.697	52.988	59.444
Anorthite	6.130	2.499	1.548	2.176	0.714	3.887	8.230	7.886	0.752	1.551	0.346
Corundum	—	—	—	—	—	—	—	0.712	1.222	—	—
Magnetite	2.400	1.035	3.265	1.542	5.371	1.399	2.075	0.335	2.136	—	—
Wollastonite	0.244	—	6.553	5.772	—	1.437	—	—	—	0.991	1.428
Enstatite	—	—	—	—	1.305	—	0.983	—	0.490	—	—
Ferrosilite	—	—	—	—	0.066	—	0.112	—	0.105	—	—
Quartz	—	—	—	—	0.860	—	2.647	—	0.651	—	1.179
Diopside	6.393	—	7.502	1.107	—	1.667	2.361	—	—	—	0.645
Forsterite	—	—	—	—	—	—	—	0.885	—	—	—
Fayalite	—	—	—	—	—	—	—	0.765	—	—	—
Nepheline	17.499	27.055	6.084	15.540	—	5.792	—	0.352	—	1.422	—
Hedenbergite	4.567	1.172	0.372	—	—	0.741	0.269	—	—	—	—
Rutile	—	—	—	—	—	—	—	—	—	0.018	0.066
Hematite	—	—	—	—	—	—	—	—	—	0.487	0.780

NOTES

Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto. Major elements in weight percent, trace elements in parts per million, normative compositions in molecular weight percent.

Ce, La, and Nd were tested for but not detected.

Locally it appears to replace or to be intergrown with the perthite perhaps suggestive that nepheline, now natrolite, and potassic feldspar were symplectically intergrown. Stilbite and analcite were identified in thin section and were confirmed by X-ray analysis (Geoscience Laboratories, Ontario Geological Survey); they are present in minor amounts and occur similarly to natrolite.

Biotite is the common mafic mineral. In the pegmatoid syenite it occurs as 2.5 to 5 cm crumbly spheres or clots with a book-like growth form. In the alkalic phases it is a primary crystallizing phase and an alteration product of pyroxene. It is locally altered to chlorite and shows partial break-down to magnetite. It occurs as single subhedral grains interstitial to the feldspar grains and as aggregate clots. On the basis of colour two varieties are present: a more common brown biotite, and a dark green biotite. The dark green biotite occurs in those rocks also containing substantial pyroxene and/or hornblende.

On the basis of the thin sections examined, pyroxene is locally present in amounts less than 5 to 8 percent although a narrow zone within the northeastern portion of this body is characterized by greater than 20 percent pyroxene. Pyroxene occurs as subhedral to euhedral interstitial grains, locally with ragged borders. In thin section it is light to dark green in colour and strongly pleochroic. It is a clinopyroxene and approximates aegerine-augite in composition (thin section determination).

Hornblende occurs only locally in minor amounts and always as a secondary mineral pseudomorphic after and replacing pyroxene, suggestive of crystal-magma interaction under hydrous conditions. It is probably alkalic as indicated by its bluish green pleochroism.

Chlorite locally occurs as a secondary alteration of hornblende and biotite.

A carbonate mineral(s) is present in amounts ranging from 2 to less than 5 percent. It occurs as an interstitial filling between the other minerals, and thus was probably one of the last minerals to form.

Sericite is locally present as pseudomorphic aggregates interstitial to feldspar possibly after nepheline (variety gieseckite?).

Magnetite is ubiquitous, in amounts from 8 to less than 1 percent, averaging about 2 to 3 percent. Locally it occurs as an alteration of biotite. As mentioned above, veinlets of almost pure magnetite locally cut the western marginal zones of this body. It occurs as fine disseminated subhedral grains locally altered to iron oxide (variety limonite).

Other accessory minerals include: sphene, normally present in amounts of 1 to 2 percent as fine euhedral red-brown grains; apatite, present locally in amounts less than 1 percent as fine subhedral interstitial crystals; and pyrite, observed in two samples. Limonite is also locally present.

Potassic feldspar is represented by microcline (minor) and microcline perthite (major). The crystals vary from 0.3 to almost 5 cm in length though generally they average 1 cm. They are generally subhedral but are commonly intensely fractured, kinked, and veined by other minerals. Both exsolution and replacement perthite were tentatively identified.

Plagioclase is present as exsolution intergrowths within microcline perthite, as a late replacement phase on the margins of the perthite grains, as fine euhedral interstitial grains, and in fine-grained veinlets that fill the fractures within the perthite grains. It is sodic (albitic) in composition. Cancrinite veinlets were locally observed cutting the plagioclase grains suggesting cancrinite formation post-dated development of the feldspar mineral phases.

Minor amounts of replacement antiperthite suggest that potassic fluids were locally active.

Border Zone. The border monzonite and syenomonzonite, variable to quartz monzonite comprise the following mineral assemblage: subhedral plagioclase grains, generally normally zoned with calcic cores and more sodic rims, the calcic cores are usually altered to saussurite; microcline that occurs as both replacement antiperthitic rims on the plagioclase grains and as interstitial grains; quartz in amounts of 5 to 20 percent as subangular

corroded grains; alkali hornblende that occurs pseudomorphically after clinopyroxene; minor interstitial biotite and accessory minerals including sphene, calcite, and magnetite.

QUATERNARY

Pleistocene

During the Pleistocene Epoch, the map-area was covered by several ice sheets, the last of which, the Patricia Ice Mass (Zoltai 1965a), retreated at the end of the Wisconsin stage. The pre-Pleistocene topography was extensively modified by these ice sheets and ice-dammed glacial Lake Agassiz.

Glacial striae, eskers and esker-outwash, and glacial fluting trend relatively consistently southwest to south-southwest, although striae in the North Arm area trend southwest to south.

Most of the area is covered by a thin layer of ground moraine (till) of unknown thickness locally reworked by lake action. Exposed outcrop no doubt resulted from washing by glacial lake action. Minor morainic ridges lie in the area between East Bay and Squaw Lake where they trend approximately southeast, and east of Vanessa Lake, where their trend swings around from east-southeast to almost east. They have many of the features of washboard moraines described by Zoltai (1965a, p.254):

> They consist of elongated straight hills, their long axis being invariably at right angles to the latest direction of ice flow indicated by striae and eskers. Although they are only about 100 feet wide at the base and their height is usually less than 20 feet, they are often a mile long. They occur regularly in groups of 5 to 20, the distance from crest to crest being less than 500 feet.

Morainic ridges form at or near the ice margins in deep water (Elson 1967, p.86) and thus may be useful in delimiting Glacial Lake Agassiz.

Eskers and esker-outwash complexes are locally present within the map-area. They are generally of limited extent, semi-continuous, and exhibit low, positive relief. They commonly have a sinuous shape, breaking and rejoining frequently, often enclosing small lakes in a braided pattern. Exposed cross-sections through them were almost non-existent.

Recent

Recent swamp or muskeg deposits are common, though generally of limited extent. These deposits are generally organic in nature, locally approaching peat. Sand beaches are rare and where present appear to have formed due to lacustrine reworking of Pleistocene deposits. Detailed information about the soil types present in the Lake Agassiz region can be found in Elson (1961).

CORRELATION OF GEOLOGY WITH AEROMAGNETIC DATA

The map-area was surveyed aeromagnetically in 1961, and is covered at a scale of 1:63 360 by Maps 1118G and 1108G (ODM-GSC 1961). While these maps have been superceded in some ways by detailed ground magnetic surveys (Barlow 1974a, 1975a) the scale of the aeromagnetic maps is useful in picking out and geologically interpreting large-scale magnetic patterns.

Perhaps the major feature is the contrast in both the magnetic pattern and response between the metavolcanic sequence exposed on and west of Sturgeon Narrows – Northeast Arm and the metavolcanic-metasedimentary sequence exposed to the east. The major change, from the western granitic complex into the western metavolcanic sequence, is an inflection in the magnetic pattern rather than a change in magnetic response as might be expected. Along the Northeast Arm – Sturgeon Narrows zone there are magnetic lows and a further change in the magnetic inflection. To the east the magnetic contours are more closely spaced, the magnetic pattern is more complex, and the overall magnetic response is much higher than to the west, reflecting not only the contrasting lithologies but perhaps a major difference in crustal and supracrustal structure as well.

In the eastern part of the map-area the magnetic contours closely parallel the contact between the eastern granitic complex and the metavolcanic-metasedimentary sequence. Also a series of magnetic lows extend along the Flindt River and Vanessa Lake, and a series of magnetic highs over the granitic rocks to the east, reflecting both the contrasting susceptibilities of the different lithologies and the abruptness of the assumed fault contact.

The pronounced magnetic high (≥ 63000 gammas) located east of Vista Lake is probably due to iron formation. No outcrop was found in the immediate area of this magnetic high.

Both the Squaw Lake Alkalic Complex and that part of the Sturgeon Narrows Alkalic Complex that lies within the present map-area are marked by subcircular magnetic patterns composed of a series of magnetic highs surrounding a central magnetic low. The magnetic highs immediately to the west and southwest of the Squaw Lake Alkalic Complex extend beyond the surface exposure of this body suggesting, that if these magnetic highs are indeed associated with this complex, the complex possibly widens at depth. The magnetic pattern of the Sturgeon Narrows Alkalic Complex has been referred to in Trowell (1976): "The Sturgeon Narrows Alkalic Complex possesses a distinctive magnetic pattern. The outer portion of this body is outlined by a series of arcuate magnetic 'highs' while a magnetic 'low' overlies the central part."

Local magnetic highs over areas underlain by metasediments might be point anomalies over thin units of iron formation. In general the metasediments have a magnetic pattern similar to the metavolcanics though their magnetic response is slightly lower.

There is a marked contrast in the magnetic response of the Vista Lake intrusion and the metasedimentary assemblage to the west, the Vista Lake intrusion having a slightly higher response. Thus, while the contact is a transitional zone marked by increasing metamorphic grade accompanied by minor hybridization and migmatization it is clearly defined on the aeromagnetic map.

The felsic to intermediate metavolcanics cannot be readily distinguished on the basis of their magnetic response or pattern from the mafic to intermediate metavolcanics, due to the similar magnetic susceptibilities and also due to local magnetic highs attributable to iron formation and mafic intrusive bodies that distort both the response and pattern.

STRUCTURAL GEOLOGY

The Squaw Lake-Sturgeon Lake volcanic-sedimentary sequence has been deformed by at least three phases of folding and by faulting. The rocks were first isoclinally (flexural-slip) folded about subhorizontal axes producing a major north-trending synformal fold, the axis of which is situated in assemblage G and perhaps assemblage F (see Figure 2) and along which the Vista and Vanessa Lake plutons were emplaced. This initial phase of folding produced a foliation that in most areas developed subparallel to bedding. The area is dominated by the west limb of this fold giving it an apparent monoclinal configuration.

The second phase of folding comprised the development of generally smaller folds of variable amplitude along generally subvertical fold axes. These folds developed both along and across the foliation of the initial phase of folding, and reflect more localized deformation events.

The third phase of folding is perhaps exemplified by kink folds representing more brittle strain and may be associated with late local faulting.

Faulting was probably associated with all phases of folding. The initial development of large regional faults or zones of cataclasis, such as the Sturgeon Narrows – Northeast Arm zone, was conformable to both initial foliations and stratigraphy; the later development of cross faults was transgressive to the regional foliation. Later kink folds here appear to be associated with regeneration of earlier conformable fault structures.

Minor Structures

FOLIATION, SCHISTOSITY, CRENULATION

Most of the metavolcanics and metasediments have a moderately to well developed metamorphic foliation. Schistosity, a foliation defined by platy or micaceous minerals such as biotite, chlorite, and muscovite occurs as a penetrative planar structure, specifically along Sturgeon Narrows and the Northeast Arm, and also defining narrow shear zones or faults.

Foliation is generally subparallel to primary structures such as flow contacts and bedding. It is locally discordant as in metasedimentary assemblage H and in those areas of metavolcanics showing a complex deformational history, i.e., the development of more than one foliation due to cross-folding. The earliest foliation appears to be of the axial-plane variety whereby the foliation is sub-parallel to the axial surface of the first generation folds while the later crenulation foliations appear to have locally developed obliquely to the earlier foliation.

GNEISSIC STRUCTURE

A gneissic structure marked by alternating layers or lenticules of different composition is locally developed in amphibolite facies metavolcanics and metasediments, specifically along the eastern border of the volcanic-sedimentary belt, and in the early granodioritic and trondhjemitic phases of the granitic intrusive complexes. In the amphibolite-facies metavolcanics a gneissic structure has developed by a process of metamorphic differentiation while in the amphibolite-facies mafic tuffs and metasediments, metamorphic differentiation and segregation mimetic after original bedding has produced the well foliated to gneissic structure. As the ultimate origin of the rocks of the granitic intrusive complexes is uncertain, the origin of the gneissic structure in the early granodioritic and trondhjemitic phases is uncertain. It could have formed as a result of tectonism and metamorphic differentiation or possibly it could have formed as a result of primary flow layering.

LINEATION

Lineations predominantly comprising intersections of S-planes but also including fold axes, long dimensions of lithic clasts, and preferred mineral orientation are present in the metavolcanics and metasediments and locally in the felsic intrusive rocks. These lineations generally lie in the foliation plane, except for those in the granitic rocks east and northeast of Vista Lake where they trend west approximately perpendicular to foliation, with plunges varying from 60 to 80 degrees west. Many of the lineations along the Northeast Arm plunge subvertically, locally doubly plunging, in the foliation plane and may be slickensides reflecting vertical movement along the postulated Sturgeon Narrows – Northeast Arm fault zone. The elongation of clasts is difficult to evaluate because their original shape is unknown.

BOUDINAGE STRUCTURE

Boudinage structure was found locally, specifically in the amphibolite facies mafic metavolcanics and metasediments along the eastern margin of the volcanic-sedimentary sequence. It appears that a phase of folding preceded boudin development.

Locally quartz and/or carbonate material occupies the neck zone between adjacent boudins and may have formed by segregation of these minerals from the host rocks and the subsequent accumulation of these minerals in the supposed low stress neck zones.

The boudins locally define a lineation though three-dimensional exposures of this structure-type are rare.

TRACHYTOIDAL TEXTURE

Trachytoidal texture is locally developed in the alkalic phases of both the Sturgeon Narrows and Squaw Lake Alkalic Complexes. The texture is defined by the subparallel alignment of coarse-grained, lath-shaped, potassic feldspar crystals and locally needle-shaped aegerine-augite crystals. This texture was probably produced by flow of semi-solid crystal mush, in which potassic feldspar and aegerine-augite crystals were aligned parallel to the flow direction and also probably parallel to the outer confining walls of the intrusive complex, as the trachytoidal texture in most cases parallels the contact with the country rocks.

KINK FOLDS, KINK FAULTS

Kink folds were developed in well foliated, finely laminated, intermediate to felsic ash tuff units (Photo 18) along the Northeast Arm of Sturgeon Lake. Specifically they were observed in two zones: (1) a major zone extending from the upper portion of Sturgeon Narrows to approximately 5 km north of Morgan Island, where they were developed in intermediate to felsic ash tuff units comprising the lower members of assemblage B, and (2) a minor subsidiary zone, also developed in intermediate to felsic ash tuff units paralleling the first, located on the western shoreline of the northeasterly bay of the island west of Morgan Island.

All of the kink folds observed in these two zones were of the singular type having one sense of external rotation and having a general monoclinic symmetry. The trend of the kink zones makes an angle of anywhere from 65 to 125 degrees with the foliation (possibly the kink folds are a conjugate set with only one type preferentially developed in any one outcrop). The foliation strikes approximately northeast and dips steeply east. The trend of the kink zones is generally constant over several metres though locally, angular differences of 25 degrees were observed between two adjacent kink zones. Widths of individual kink zones vary from a few millimetres to upwards of 10 cm while the distance between adja-

OGS 10538

Photo 18. *A kink-fold displaces the foliation of intermediate to felsic, crystal ash tuff, schist or phyllite from shoreline of Sturgeon Lake, west of Coveney Island. Kink folds are parallel sided and approximately regularly spaced.*

cent kink zones is of the order of 1 m or more. Locally, faulting showing minor displacement of 2.5 to 7.5 cm, has developed along the kink zone boundaries. As only a few kink folds were observed and measured, no interpretation regarding the stress field has been attempted.

Kink folds, or perhaps more correctly kink faults (not shown on map), were developed in finely laminated siltstone-argillite members along the southern end of Vanessa Lake near the contact with the eastern granitic complex. These kink folds or faults developed in conjugate pairs trending S20E ± 5 and S75E ± 5 degrees respectively; the bedding trends N40E ± 5 degrees and dips steeply west. Displacement along the kink zones is of the order of 2.5 to 7.5 cm, the kink zone itself is 1 to 2 mm wide.

Folding

Determination of the overall fold pattern has been hampered by the inability to determine primary planar structures and reliable facing directions, by faulting subparallel to stratigraphy, and by the complex nature of the folding itself.

The major fold structure in the area has already been discussed. Major east-trending cross folds are probably present in the vicinity of Squaw Lake where they have been pushed back-up on themselves by intrusion of the Squaw Lake Alkalic Complex.

Several small folds produced during the second phase of folding were observed along the Northeast Arm where exposure is better on wave-washed surfaces. Tight to isoclinal flexural-slip folds developed in felsic to intermediate pyroclastic rocks. The develop-

OGS 10539

Photo 19. *Isolated fold developed in two units of felsic to intermediate pyroclastic rocks from east side of the upper portion of the Northeast Arm. Compass parallels axial plane foliation/cleavage (S_1).*

ment of fine slip folds along the axial plane foliation of the first (F_1) folds (Photo 19), possibly was associated with later cataclasis along the Sturgeon Narrows – Northeast Arm zone.

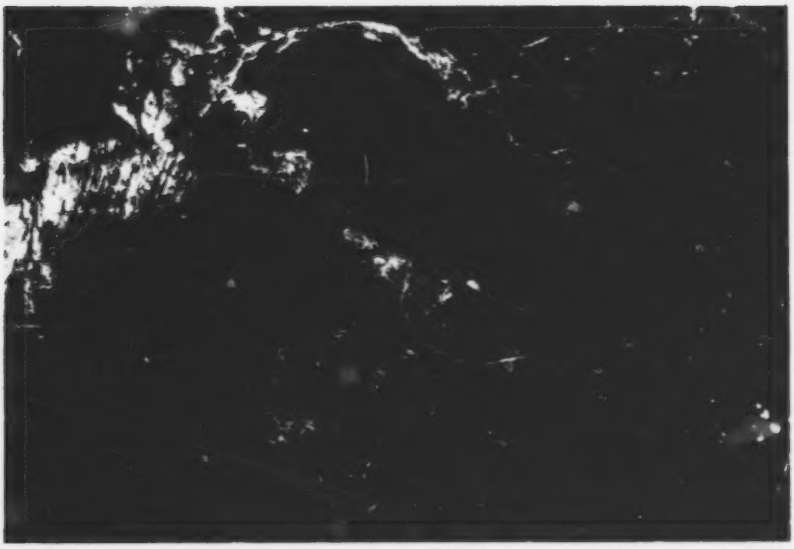
Two phases or periods of folding characterize a domain at the north end of the Northeast Arm, corresponding to a marked flexure in the metavolcanic-metasedimentary sequence from approximately northeast to northwest. First folding (F_1) of a felsic tuff unit formed tight isoclinal folds. In some cases further slip along the axial plane foliation (S_1) produced closed-eye folds. A second folding (F_2; $F_2 \wedge F_1$)produced both macro- and microcrenulations of the first foliation. The first foliation (S_1) is defined by discontinuous biotite streaks that may parallel original bedding ($S_0 + S_1$) The microcrenulations appear to have formed by slip along the second (S_2) foliation. On the hand specimen scale a clast in an intermediate tuff unit has been affected by two phases (periods) of folding (F_1 and F_2, $F_2 \wedge F_1$)both of which show concomitant or later slip along their respective axial planes causing disruption of the clast.

It is not known whether the kink folds observed along the Northeast Arm are an expression of F_2 ($F_2 \wedge F_1$) folding or whether they constitute a different phase (F_3, $F_2 \wedge F_1$).

Small parasitic (drag) folds were also observed along the Northeast Arm but their orientations did not help to elucidate the overall fold pattern.

Flexural-slip folds (Photo 20) were observed in metasedimentary assemblage H along and south of East Bay; the foliation (S_1) approximately parallels bedding (S_0). The folds tend to complicate the interpretation of the facing directions in these rocks. In thin section the knotted metasediments, especially, show microcrenulations or plications of the first (S_1) foliation. Andalusite poikiloblasts tend to grow preferentially in these plications.

Folding was also observed in the early quartz lenticule trondhjemite and granodiorite



OGS 10540

Photo 20. *Flexural-slip fold (similar variety) in siltstone-argillite unit of metasedimentary assemblage H. From north shore of Coveney Island, East Bay.*

gneisses of the eastern granitic complex (see "General Geology"). As well, various fold patterns were observed in the amphibolite facies metavolcanic and metasedimentary units along the contact zone with the eastern granitic complex (Photo 21)

Faulting and Cataclasis

Several faults, and lineaments which are the topographic expression of probable faults, were recognized in the map-area. Many of the assumed faults are subparallel to stratigraphy. In general the faults and lineaments trend north-northeast to almost east.

Except for small faults observed on outcrop surfaces the major faults are generally not exposed but are marked by linear scarps and valleys. Other expressions of faults are alteration zones marked by epidote- or hematite-rich zones in the granitic complexes and carbonatization or silicification in the metavolcanic-metasedimentary sequence, shear zones, abrupt changes in structural style, abrupt changes in metamorphic grade, breccia zones, and offset of lithological units. In thin section the presence of faults is suggested by such cataclastic textures as fluxion structure, microbreccia, and shattered porphyroclasts.

A fault has been interpreted along a portion of the contact between the metavolcanic-metasedimentary sequence and the eastern granitic complex. This fault and adjacent faults that are slightly discordant to the batholith complex and the metavolcanic-metasedimentary sequence have a positive topographic expression comprising the height of land separating two major drainage systems. Other faults were assumed to be present in the granitic rocks east of Vista Lake where there are changes in structural style from highly

OGS 10541

Photo 21. *Box fold produced by plastic deformation accompanying intrusion of trondhjemite phase of eastern granitic complex into amphibolite facies metasediments. From southern portion of Vista Lake.*

folded quartz lenticule granodiorite and trondhjemite gneisses to well-foliated and locally gneissic granodiorite and trondhjemite.

A major zone of cataclasis appears to extend along Sturgeon Narrows and the Northeast Arm. In the Northeast Arm area its presence is indicated by the presence of several minor shear zones, often along the eastern and western shores of the islands along the Northeast Arm, by various degrees of alteration specifically carbonatization, and by internal microscopic cataclastic features. In the Sturgeon Narrows area it is indicated by hematitic alteration and breccia zones in the Sturgeon Narrows Alkalic Complex. This zone is also marked by distinct magnetic and gravimetric patterns and responses (ODM-GSC 1961; Barlow 1975b).

The Squaw Lake Alkalic Complex has been faulted and also shows evidence of internal microscopic (protoclastic?) deformation.

ECONOMIC GEOLOGY

Intensive exploration has been conducted in the Squaw Lake-Sturgeon Lake area since 1969 when the Exploration Division of Mattagami Lake Mines Limited discovered a base metal (Zn, Cu, Ag, Pb, Au) sulphide deposit (now mined by Mattabi Mines Limited) south of Sturgeon Lake, just west of the boundary line between the Districts of Kenora and Thunder Bay.

Exploration activity was further heightened by two subsequent discoveries in 1970 and 1971. In 1970 Falconbridge Nickel Mines Limited discovered a base metal sulphide deposit on their Lyon Lake property which they had optioned from New Brunswick Uranium Mining and Metals Limited. In 1971, the Exploration Division of Mattagami Lake Mines Limited discovered a base metal sulphide deposit near Lyon Lake north of the Falconbridge Nickel Mines Limited discovery site (also see Table 1).

Gold

Table 11 lists several gold occurrences in the map-area that have been described with respect to general geology, structure, and mineral assemblages. All have as their primary host quartz veins, masses, or segregations. The quartz veins occur in two modes: (1) in association with granitic intrusions; and (2) isolated veins within the metavolcanics and metasediments. With the exception of the East Bay occurrence, all occurrences have a close spatial relationship to mafic metavolcanics. Other common associations are quartz veins with carbonate (one gold-bearing carbonate zone does not contain quartz), and quartz veins with sulphide facies iron formation. The common mineral assemblage is quartz + carbonate ± tourmaline + sulphides (chalcopyrite + pyrite). Significant sphalerite and galena were reported at only two occurrences, the St. Anthony Mine and the Dawson-White occurrence (property 21 on map) which occur at approximately the same stratigraphic level in mafic metavolcanic assemblage A.

The author would suggest that the mafic metavolcanics were the source of the gold, that initial gold concentration occurred in siliceous sulphide or sulphide + carbonate exhalative units, and that further gold concentration occurred as a result of igneous activity, structural dislocation, quartz veining, or segregation and possibly metamorphic segregation.

The St. Anthony Mine was rich in Au and Ag because the intrusive phase, the St. Anthony Pluton, was large enough to provide the necessary heat, silica, water, and volatiles and structural dislocation to effect a substantial concentration of Au and Ag in what was possibly a sulphide-carbonate exhalative unit.

The carbonate breccia map-unit contains anomalous gold values in the 20 to 250 ppb range.

Quartz-Carbonate Veins

Numerous brown-weathering quartz-carbonate veins or dikes and sills are present along the central portion of the Northeast Arm of Sturgeon Lake. They also occur intermittently along Sturgeon Narrows (Trowell 1976). The units commonly are parallel to stratigraphy and where folding has occurred, they also are folded. In general, they are of the order of 0.3 to 1.5 m wide and traceable along their length for one to several metres. They locally cut the trend of the metavolcanics. They are zoned in places with the quartz concentrated centrally. In thin section these units are seen to consist of coarse-grained low-iron dolomite and fine-grained quartz. The dolomite grains often show kinked structures while the quartz occurs in veinlets apparently intrusive into the carbonate. Sulphides, generally pyrite, are locally present in amounts of 1 to 3 percent. They contain traces of gold and copper. The author would speculate that these units were perhaps originally stratabound siliceous car-

TABLE 11. GEOLOGY AND MINERALOGY OF SELECTED GOLD OCCURRENCES IN THE SQUAW LAKE—STURGEON LAKE AREA.

Occurrence	Geology	Host	Element	Mineral assemblage
Can-Con Enterprises and Explorations Limited (St. Anthony Mine)	Mafic metavolcanics intruded by granodiorite-trondhjemite (St. Anthony Pluton) with subsequent hydrothermal alteration of both.	Quartz vein/stockwork/ breccia zone in granodiorite-trondhjemite.	Au,Ag	Quartz + carbonate + sphalerite + galena + chalcopyrite + pyrite
Pomac Mines Limited (Dawson-White occurrence)	Mafic metavolcanics intruded by granodiorite dikes and quartz vein.	Quartz vein.	Au,Ag	Quartz + chalcopyrite + galena + sphalerite
Steep Rock Iron Mines Limited (shore occurrence)	Mafic metavolcanics with interflow unit of sulphide facies iron formation intruded by trondhjemite dikes and quartz vein/segregations.	Quartz vein/segregation at contact between trondhjemite and metavolcanics.	Au	Quartz + pyrite (marcasite) + pyrrhotite + chalcopyrite
East Bay area (adit north of Coveney Island)	Metasediments with intercalated band of sulphide facies iron formation intruded by quartz vein	Quartz vein.	Au	Quartz + pyrite + chalcopyrite (+ pyrrhotite?)
Fortier, C.	Mafic metavolcanics intruded by quartz vein	Quartz vein.	Au	Quartz + chalcopyrite + tourmaline
Beckett, P. V.	Sheared and altered mafic metavolcanics.	Carbonate shear zone.	Au	Carbonate + ?
Koval, D. (Ouillette Mines Limited)	Mafic metavolcanics in contact with felsic metavolcanic/intrusive rocks intruded by quartz veins.	Quartz veins approximately along contact between mafic and felsic rocks.	Au	Quartz + carbonate + pyrite + tourmaline
Johnson, S. (Davidson Carr occurrence)	Quartz vein (cherty unit?) along contact between mafic and felsic metavolcanics.	Quartz vein (cherty unit?).	Au	Quartz + carbonate + pyrite + chalcopyrite + fuchsite
Northeast Arm area (several showings)	Mafic metavolcanics intruded by quartz and quartz-carbonate veins; quartz and quartz-carbonate veins along contact between mafic and felsic metavolcanics.	Quartz and quartz-carbonate veins.	Au	Quartz + carbonate + pyrite + chalcopyrite ± fuchsite

bonate units (exhalites) which during metamorphism and deformation were mobilized into their present positions.

Sulphides, Sulphide Iron Formation

Pyrite, pyrrhotite, and in a few places, minor chalcopyrite, generally less than 1 to 2 percent, are locally disseminated in the metavolcanic units.

Several of the felsic to intermediate pyroclastic units exposed in the northern portion of the map-area contain clot-like or nodular concentrations of sulphide minerals, generally pyrite with minor pyrrhotite and trace chalcopyrite that constitute up to 10 percent of the particular rock unit. The mineralized zones generally extend 1.5 to 3 m along strike and are 0.3 to 1.5 m wide.

A narrow 1.5 to 0.8 m siliceous zone containing from 3 to 10 percent sulphide minerals occurs along the west shore of Vanessa Lake. The zone lies between a massive amphibolite (massive mafic flow) unit on the west and a pillowed volcanic flow unit on the east; the zone strikes approximately north, dips 75W, and is exposed for 3 m strike length along the shore. The sulphide minerals consist predominantly of pyrite and pyrrhotite occurring as breccia fragments set in a siliceous matrix.

A 1.8 m thick zone of sulphide iron formation occurs in the metasediments on the eastern shoreline of a small lake west of the north end of Vista Lake. The zone is exposed for 2.1 m and is stratigraphically concordant to the surrounding metasediments striking N70E and dipping 85 degrees north. The zone can be roughly subdivided into four separate subzones from north to south: massive sulphide; disseminated sulphide in argillaceous groundmass; interlaminated sulphide and argillite; and a breccia subzone of sulphide fragments set in an argillaceous groundmass. The outcrop shows recent signs of prospecting, primarily blasting and trenching.

Diamond-drill hole information which has been filed for assessment credit (Assessment Files Research Office, Ontario Geological Survey, Toronto) mentions several occurrences of sulphide mineralization, specifically: pyrite and pyrrhotite mineralization locally with minor chalcopyrite in the amphibolitic mafic metavolcanics along the eastern part of the Sturgeon Lake metavolcanic-metasedimentary belt; graphitic sulphide (pyrite, pyrrhotite) zones, intersected in the metasedimentary sequence near Vanessa Lake, and local sulphide intersections in both mafic to intermediate and felsic to intermediate metavolcanics.

The mafic intrusive rocks locally contain small areas showing sulphide (pyrite, pyrrhotite, locally chalcopyrite) concentrations (2 to 5 percent). Analyses by the Geoscience Laboratories, Ontario Geological Survey, of grab samples collected by the field party indicate the presence of only trace amounts of base and precious metals.

Most of the granitic intrusive rocks, including both batholithic complexes do not, in general, appear economically interesting. The (porphyritic) trondhjemite-granodiorite phase of the western complex is of interest with reference to its association with gold occurrences (see "Massive Trondhjemite, Porphyritic Trondhjemite") and also with reference to the local sulphide (generally pyrite) concentrations within it along its contact with mafic metavolcanic assemblage A.

Fluorite

Disseminated fluorite mineralization was observed in all of the rock units of the Sturgeon Narrows Alkalic Complex in amounts generally less than 0.5 to 1 percent. A zone, within this complex, characterized by the presence of upwards of 1 to 2 percent disseminated

fluorite and locally almost pure fluorite along joints is located on the south shore of East Bay directly south of Coveney Island.

Magnetite

Magnetite is a ubiquitous mineral in the Squaw Lake Alkalic Complex. It is disseminated throughout the entire complex in amounts of 1 to 2 percent. Locally it occurs as clot-like aggregates comprising 3 to 5 percent of the particular rock unit. Along the western contact of this complex with the metavolcanic sequence, local magnetite veins and veinlets cut the border phases of this complex. It is possible that the high magnetic responses along the western and southern sides of the complex might be due to either local magnetite concentrations or to mafic intrusive bodies.

Magnetite grains, locally constituting upwards of 2 to 3 percent of a particular rock, occur within the pyroclastic rocks and volcanogenic metasediments. They could be detrital in origin.

Radioactivity

Rodgers (1964, p.42-44) measured the radioactive response of both the Sturgeon Narrows Alkalic Complex and the Vista Lake Intrusion and reported areas of radioactivity 3 to 6 times above background, associated particularly with pegmatitic and syenitic dikes of the alkalic complex.

The author visited several of the localities mentioned in Rodger's report and found that the radioactive responses of these intrusions were essentially as reported by Rodgers.

Uranium and Niobium

Rodgers (1964, p.46) checked several samples of the Sturgeon Narrows Alkalic Complex for uranium and niobium but found only trace values.

Description of Properties

Table 12 shows assessment and other information that has been submitted or was available in earlier reports of the Squaw Lake Sturgeon Lake area, up to the end of August 1974. The majority of the diamond-drill holes are located on the map face (Map 2420, back pocket). Several diamond-drill holes, however, could not be located in the field nor could they be accurately located from the assessment files submitted, and thus are not shown on the map face.

Information concerning the described occurrences and past and current properties was obtained from published reports and maps of the Ontario Geological Survey and the Geological Survey of Canada, and from the Assessment Files Research Office, Ontario Geological Survey, Toronto.

TABLE 12. SUMMARY OF EXPLORATION WORK IN THE SQUAW LAKE—STURGEON LAKE AREA.

File Name	Type of Work	Toronto Assessment File	Year	Remarks
1 Amax Expl. Inc.	AMAG	63.2767	1969	
	MAG	2.336	1970	
	AMAG, HEM	2.158	1970	
	GEOL	2.568	1971	
	AMAG, HEM	2.159	1970	
		2.569	1971	
2 Beckett, P. V.	TR			Previous work by Bennett Pacaud Interests
3 Bordun Mining (Quebec) Ltd.	MAG, HEM	63.2759	1970	
	VLF	2.693	1971	
4 Bucke, H.W.W.	TR, DEV			Previous work by W. Lediet.
5 Canadian Nickel Co. Ltd.	2-DDH, 113.7 m		1969	
6 Can-Con Enterprises and Expl. Ltd.	TR, DEV			Property includes St. Anthony Mine; previous work by Jack Lake Gold Mining Co. Ltd., St. Anthony Gold Mining Co. Ltd., J. Steele, G. Clendinning, Sturgeon Lake Dev. Co., Northern Gold Reef Ltd., St. Anthony Dev. Co. Ltd., Thunder Mining Co. Ltd., Campbell et al, St. Anthony Gold Mines Ltd., St. Anthony Mines Ltd., Con-Key Mines Ltd.
7 Conwest Expl. Co. Ltd.	MAG, HEM	63.2813	1970	
	AMAG, AEM	2.500	1971	
8 Fortier, C.	TR			Previous work under control of Messrs. Forget, Rowan and Daigle.
9 Grannis, F. H.	TR, DEV			Locally known as 'Symmes Prospect', previous work by individuals and Huronian Belt Co. (1928).
10 Hannula, L.	DEV			Previous work by Belmore Bay Mining Co. Ltd.
11 Johnson, S.	TR, DEV			Known locally as 'Davidson Carr Mine', previous work by Golden Centre Mining Co., McCrae Mining Corp. Ltd., File 2.253.
	DEV			Locally known as the 'Powell Property'.
12 Kerr Addison Mines Ltd.	MAG, VEM, VLF	2.885	1972	

CONTINUED

TABLE 12. CONTINUED.

File Name	Type of Work	Toronto Assessment File	Year	Remarks
13 Koval, D.	TR, DEV			Previous work by Anglo-Canadian Gold Estates (A. Sullivan), Richelieu Gold Mines Ltd., Ouillette Mines Ltd.
14 Kratzendein, B.	TR, DEV			Previous work under Messrs. King and Frazer, patented Claim HW686 known locally as 'Martin's Claim'.
15 Larchmont Mines Ltd.	1-DDH, 45.7 m		1947	
	AMAG, AEM	2.463	1971	
16 Mattagami Lake Mines Ltd.	MAG; HEM; SP; GEOL	63-81	1946	Survey on behalf of C. J. Ryan
	AMAG, AEM, MAG, HEM, 11-DDH, 809.8 m		1946/47	
	MAG, HEM, GEOL	63.2819	1969	
	MAG, HEM	2.347	1971	
17 McRae Mining Corp. Ltd.	AMAG, AEM	2.253	1970	
18 O'Flaherty, K.	DEV			Previous work by K. T. Barnard, locally known as 'Rainbow Mine (?)'.
19 Omar Expl. Inc.	MAG, VEM	2.264	1970	
20 Phelps Dodge Corp. of Canada Ltd.	MAG	2.356	1971	Also see Theriault, A. et al, File 2.135.
	MAG, HEM	2.1220	1973	
21 Pomac Mines Ltd.	MAG, EM, TR, DEV	63.3323	1965	Previous work by Sturgeon Lake Mining Co. Ltd., English River Gold Mining Co. Ltd., Dawson-White Gold Mines Ltd.
22 Rowland, E.R.	DEV			Locally known as 'Coveney Prospect', previous work recorded.
	TR			Locally known as the 'Northern Light Mine'. Previous work by Douglas Mining Co.
	10-DDH, 424.0 m		1955	Work by L. Anderson.
23 Royex Mining Ltd.	MAG, VEM	63.2912, 2.254	1970	
	MAG, VLF	2.592	1971	
	MAG, HEM, 1-DDH, 94.8 m	2.1049	1972	
24 Scobie, W.	MAG, HEM	2.1049	1972	Also see Conwest Expl. Co. Ltd. File 2.500.

CONTINUED

TABLE 12. CONTINUED.

File Name	Type of Work	Toronto Assessment File	Year	Remarks
25 Selco Exploration Co. Ltd.	MAG, HEM, 11-DDH, 1196 m	2.17, 2.574	1970	
	HEM	2.218	1971	
	MAG, HEM, 2-DDH, 223.1 m	2.210	1970	
	MAG, HEM	2.19, 2.572	1970	
	MAG, HEM, 1-DDH, 40.2 m	2.18, 2.573	1970	
26 Silverside Mines Ltd.	AMAG, AEM	2.151	1970	
	MAG, HEM, 6-DDH, 182.9 m	2.942, 2.1037	1971	
27 Spooner Mines & Oils Ltd.	AMAG, AEM	2.58	1970	
(Granges Exploration AB option)	HEM	2.952	1972	
28 Steep Rock Iron Mines Ltd.	DEV			Previous work by United States Gold Mining Co.
29 Steine, M.	DEV			Previous work.
30 Sturgex Mines Ltd.	MAG, EM, 12-DDH, 1220.2 m	2.252	1970	
	MAG, EM, 4-DDH, 544.7 m	2.1049	1972	
31 Tay River Mines Ltd.	HEM, 4-DDH, 158.5 m	2.530	1971	
32 Theriault, A. et al.	MAG, VEM, 2-DDH, 430.1 m		1970	Also see Phelps Dodge Corp. of Canada Ltd., File 2.1220.
33 Utica Mines Ltd.	HEM	2.111	1970	
34 Western Quebec Mines Co. Ltd.	AMAG, AEM, 2-DDH, 302.1 m	2.426, 2.594	1971	
	GEOCHEM	2.674		

ABBREVIATIONS

AMAG—Airborne magnetometer
AEM—Airborne electromagnetic
MAG—Ground magnetic
EM—Ground electromagnetic
HEM—Ground electromagnetic, horizontal loop
VEM—Ground electromagnetic, vertical loop
VLF—Very low frequency electromagnetic
SP—Self potential
GEOL—Geological mapping
2-DDH, 200 m—Diamond drilling, no. holes, total depth
GEOCHEM—Geochemistry
TR—Trenching
DEV—Development work

AMAX EXPLORATION INCORPORATED [1971] (1)

In 1970, Amax Exploration Incorporated held three groups of unpatented claims: (1) 25 claims on and in the area of Coveney Island, (2) 30 claims on the south-central part of Vanessa Lake, and (3) 8 claims approximately 3 km (2.0 miles) northeast of Squaw Lake. Claim groups were subsequently dropped.

Group 1. In 1969 Amax Exploration Incorporated conducted an airborne magnetic survey over the claim group, followed in 1970 by a ground magnetic survey. The former property is underlain predominantly by the syenogabbro-syenodiorite zone of the Sturgeon Narrows Alkalic Complex in the east and mafic to intermediate metavolcanics and intrusive rocks in the west. Disseminated fluorite (1 to 2 percent) occurs in the syenitic rocks south of Coveney Island.

Group 2. In 1970 Amax Exploration Incorporated conducted ground magnetic and electromagnetic, and geological surveys over the claim group. The eastern and western shores of Vanessa Lake are underlain by amphibolite facies mafic metavolcanics and thin intercalated units of metasediments, while Vanessa Lake itself is apparently underlain by the Vanessa Lake granodiorite-monzonite intrusion.

Group 3. In 1970 Amax Exploration Incorporated conducted ground magnetic and electromagnetic surveys and in 1971 geological surveys over the claim group. Only a few scattered outcrops of amphibolitic mafic metavolcanics were located.

P.V. BECKETT (2)

In 1974, P.V. Beckett held five patented claims (AL772, TB4300, SV410-412) east of Couture Lake 2.5 km northeast of the St. Anthony Mine.

Graham (1931, p.49, 50) referred to the workings on these claims:

> The Bennett Pacaud interests are carrying on the development of a group of 5 claims, A.L. 771, 772, and S.V. 410-12, to the east of Couture Lake. Trenching has uncovered in andesite a quartz vein, 2 to 8 feet wide, carrying commercial-grade ore over a length of 600 feet. A carbonate zone in sericite schist, which can be followed for 1,000 feet, carries low gold values across 10 feet. It is the intention of the company to diamond-drill the main vein in order to test the continuance of values at depth.

The author found no further records on this property to indicate whether any other exploration work was carried out. The field party did not locate the trenches referred to by Graham (1931).

BORDUN MINING (QUEBEC) LIMITED [1971] (3)

In 1971, Bordun Mining (Quebec) Limited held a group of eight unpatented claims approximately 1.6 km southwest of the west end of King Bay.

In 1970, Bordun Mining Corporation Limited conducted ground magnetic and electromagnetic surveys over the claim group. In 1971, Bordun Mining (Quebec) Limited acquired Bordun Mining Corporation Limited, and carried out a ground electromagnetic survey over the eight-claim group. The claims were subsequently dropped.

This former property is underlain by an assemblage of mafic metavolcanic flows and thin intercalated felsic to intermediate pyroclastic units.

H.W.W. BUCKE (4)

In 1974, H.W.W. Bucke held two patented claims (TB720, TB953) on the east shore of the North Arm of Sturgeon Lake, west of the north end of Couture Lake.

Moore (1911, p.148) described the workings on these claims, the south portion of HW704 now being TB953:

Besides a large number of pits, too numerous to mention individually, there are two more shafts near the east shore of North Bay. One of these is on claim H.W. 704, along the contact between granite and green schist. This shaft is about 48 feet deep, and was sunk by William Lediet on an irregular quartz lode, which is made up of stringers and lenses of quartz in the schist extending the width of the shaft. The quartz and schist are impregnated with pyrite, but we did not find any visible gold.

The workings were not found by the present field party.

CANADIAN NICKEL COMPANY LIMITED [1969] (5)

In 1969 Canadian Nickel Company Limited drilled two diamond drill holes, with a total length of 114 m, on an unsurveyed claim east of Wellington Lake. The diamond drill holes intersected an assemblage of mafic metavolcanics and amphibolite, metasediments, felsic metavolcanics, and graphitic schist units containing disseminated pyrite and pyrrhotite. The claim was subsequently dropped.

CAN-CON ENTERPRISES AND EXPLORATION LIMITED (ST. ANTHONY MINE) (6)

In 1974, Can-Con Enterprises and Exploration Limited held 12 patented claims (BG151-154, BG168, HW699, HW744-746, TB11414-11416) in the Couture Lake area. A hydro-electric plant and other buildings are located on two other patented claims: SV396 (located at the entrance of Vista Creek to Squaw Lake, not shown on map) and SV415 also held by the company.

The St. Anthony Mine, a past producer of Au and Ag is located on claims BG151 and BG152. Table 13 summarizes production at the mine.

History and Development

Ferguson *et al.* (1971, p.293-294) have summarized the history of this mine with respect to ownership, development work and production.

History: 1900-03: Pitting, trenching and shaft sinking, Nos. 2 and 3 to a depth of 100 feet with a level at that depth. Crosscutting from No.2 shaft totalled 140 feet and from No. 3 shaft 110 feet; a small amount of drifting was done from both. A 10-stamp mill was constructed. Work by Jack Lake Gold Mining Co. Ltd.

1904-07: Drifting totalling 440 feet and crosscutting 65 feet. Work by St. Anthony Gold Mining Co. Ltd.

1907-12: Jack Lake No. 2 shaft deepened to 175 feet with a level at 150 feet, from which No. 1 winze was sunk 100 feet and level established at 250 feet. Drifting totalling 1,500 feet and crosscutting 615 feet. Work by J. Steele, G. Glendinning, Sturgeon Lake Development Co., and probably Northern Gold Reef Ltd.

1915-16: Sampling by St. Anthony Development Co. Ltd., controlled by The Kerr Lake Mining Co. Ltd. and Wettlaufer-Lorrain Co.

1916-18: No. 1 winze continued to 350 feet and a level established from which No. 2 winze was sunk to 525 feet, with a level at 500 feet. Approximately 1,500 feet of drifting. Work by Thunder Mining Co. Ltd.

1920-21: Clean-up work by C.L. Campbell, C.P. Charlesbois and W.H. Fairburn.

1928-41: An inclined shaft to replace Jack Lake No.2 was sunk to a vertical depth of 766 feet, shaft length 1,017 feet, and new levels established at 625 and 750 feet. No. 3 winze was sunk from the 750-foot level to a vertical depth of 1,010 feet below the surface with levels at 875 and 1,000 feet. Drift-

TABLE 13. GOLD AND SILVER PRODUCTION AT ST. ANTHONY MINE.

Years	Gold (ounces)	Silver (ounces)	Total Value (dollars)	Ore Milled (tons)
1905-07, 1911-13, 1917-18, 1920-21, 1929-30, 1934-41	63,310	16,341	2,165,292	331,069

Source: Ontario Geological Survey, Statistical Files, St. Anthony Gold Mines Ltd., Northern Gold Reef Ltd.

ing exceeded 5,684 feet and crosscutting 1,504 feet. Diamond drilling from surface exceeded 23 holes and totalled 5,763 feet; underground drilling totalled 9,597 feet in 65 holes. A 125-ton mill was constructed. Work by St. Anthony Gold Mines Ltd.

Geology and Mineralization

Several authors including McInnes (1901, p.93), Carter (1902, p.148, 149), Miller (1903, p.82-84, 86), Corkill (1908, p.64, 65), Moore (1911, p.143, 146), Gledhill (1925, p.29, 30, 38, 39), and Graham (1931, p.45-48) have described various aspects of the geology of the mine.

Graham (1931, p.45-48) described the general geology of the St. Anthony Mine:

The St. Anthony mine, one of the earliest and most important discoveries in this region, is situated on claims B.G. 151 and 152 between the North arm and Couture lake. The mine has been operated at intervals by different owners since 1901.

The main ore body is a north-south fissure vein at the contact between Keewatin pillow lavas and a small dome of granodiorite, which is an offshoot from the granodiorite boss in the North arm. A coarse quartz porphyry stock has intruded along this same contact and has caused the alteration of the granodiorite to a protogine granite consisting almost entirely of quartz and sericite. The quartz veins that accompanied the intrusion of the porphyry stock have caused alteration along their walls. The northern portion of the main vein in the granite branches and reunites to form a stockwork. The wall rock has been altered to sericite schist. The southern portion of the vein in the greenstone tends to follow the rock cleavage. The wall rock has been altered to a banded carbonate sericite schist. The veins dip slightly to the west and the ore bodies rake to the southwest following the quartz porphyry stock.

The gangue minerals are quartz, calcite, and siderite. The sulphides are pyrite, chalcopyrite, galena and sphalerite. Both galena and sphalerite are indicators of gold ore. The pyrite carries low gold values. In the granite most of the sulphides are confined within the veins; in the greenstone, the sulphides have penetrated into the wall rock, in which low gold values are found.

The main vein is 1,100 feet long on the surface, and the maximum width is 25 feet. Two other vein systems have been located on the surface, but the main vein is the only one on which underground work has been done.

Gledhill (1925, p.29, 30) had previously analyzed the ordinary mafic metavolcanics away from the gold-quartz veins and some of the rusty-weathering biotite schist bordering the veins. His results were as follows (Gledhill 1925, p.29).

	Greenstone Schist per cent	Rusty-weathering Biotite schist per cent
SiO_2	45.78	40.00
CaO	2.90	11.20
K_2O	2.77	9.06
Na_2O	3.00	0.11

The alteration of the greenstone by the hydrothermal solutions is somewhat similar to the chemical changes that occur during the formation of sericite schist, the great similarity being the gain in potash and loss of lime and the difference being the loss of silica instead of a gain as is the case in the formation of sericite schist.

Gledhill (1925, p.38, 39) further suggested a possible origin for the sericite schist at the St. Anthony mine:

At the St. Anthony gold mine, the granodiorite has been altered near its contact with the greenstones to a sericite schist. The development of this schist was accompanied by the development of high temperature gold-quartz veins. In places where the granodiorite has not been subjected to movement, the rock has been so altered that it has the appearance of a protogine granite.... The biotite of the granodiorite has been bleached to a pale green sericite, while the feldspars, which are mostly of the acid plagioclase type, have suffered little or no change in this protogine massive type.

The sericite schist is mixed in with the massive hydrothermally altered rock and occurs only where a shearing movement has taken place. It consists chiefly of quartz and sericite, with small amounts of residual acid plagioclase, which is, in most cases, almost replaced by a felty mass of sericite.

This occurrence of sericite schist springing from a rock richer in soda than potash afforded an opportunity to test the theory that in the schist-making process for alkali rocks the composition of the schist tends towards the mineral sericite. Potash has shown an increase from 2.06 percent in the fresh granodiorite to 8.36 percent in the sericite schist. This gain was checked by a count of the bleached biotites in both rocks over a unit area, and the ratio was about 1:4, the same increase as shown by potash, which has increased from 2.06 to 8.36 percent.

The analyses which follow have been made by the author and show that potash has been gained during the schist-making process and soda almost eliminated; lime and magnesia have been lost, and some silica has been gained.

	Fresh biotite granodiorite from near the St. Anthony gold mine, Sturgeon Lake Anthony gold mine, per cent	Sericite schist derived from the granodiorite, St. Sturgeon Lake per cent
SiO_2	65.50	71.80
Al_2O_3	15.40	14.38
MgO	1.70	0.21
CaO	6.13	1.69
FeO	3.60	1.02
Fe_2O_3	1.30	0.96
K_2O	2.06	8.36
Na_2O	3.15	0.20
CO_2	0.36	0.30
H_2O	1.52	1.38
	100.72	100.30

The immediate area of the St. Anthony Mine was mapped by the field party during the summer of 1973; Figure 4 is a geological sketch map of the area. Six samples were collected and subsequently analyzed for trace elements by the Geoscience Laboratories, Ontario Geological Survey; the results are shown in Table 14.

Mafic rocks in general have a higher trace element content of gold than do felsic rocks and it may be that the ultimate source for the gold was the mafic metavolcanics. Perhaps what is now the mineralized zone was originally a stratabound siliceous sulphide (pyrite, chalcopyrite, sphalerite, galena) carbonate Au-bearing zone (exhalite). The intrusion of the St. Anthony Pluton may have provided the necessary thermal energy, supply of volatiles, including water, additional silica, and mechanical disruption of this stratabound unit to effect a further concentration or upgrading of the gold values to produce a mineable economic deposit. Some credence for this hypothesis is provided by Table 14 which shows that the sample of altered mafic metavolcanics contains substantially more gold than do the samples of altered granodiorite-trondhjemite.

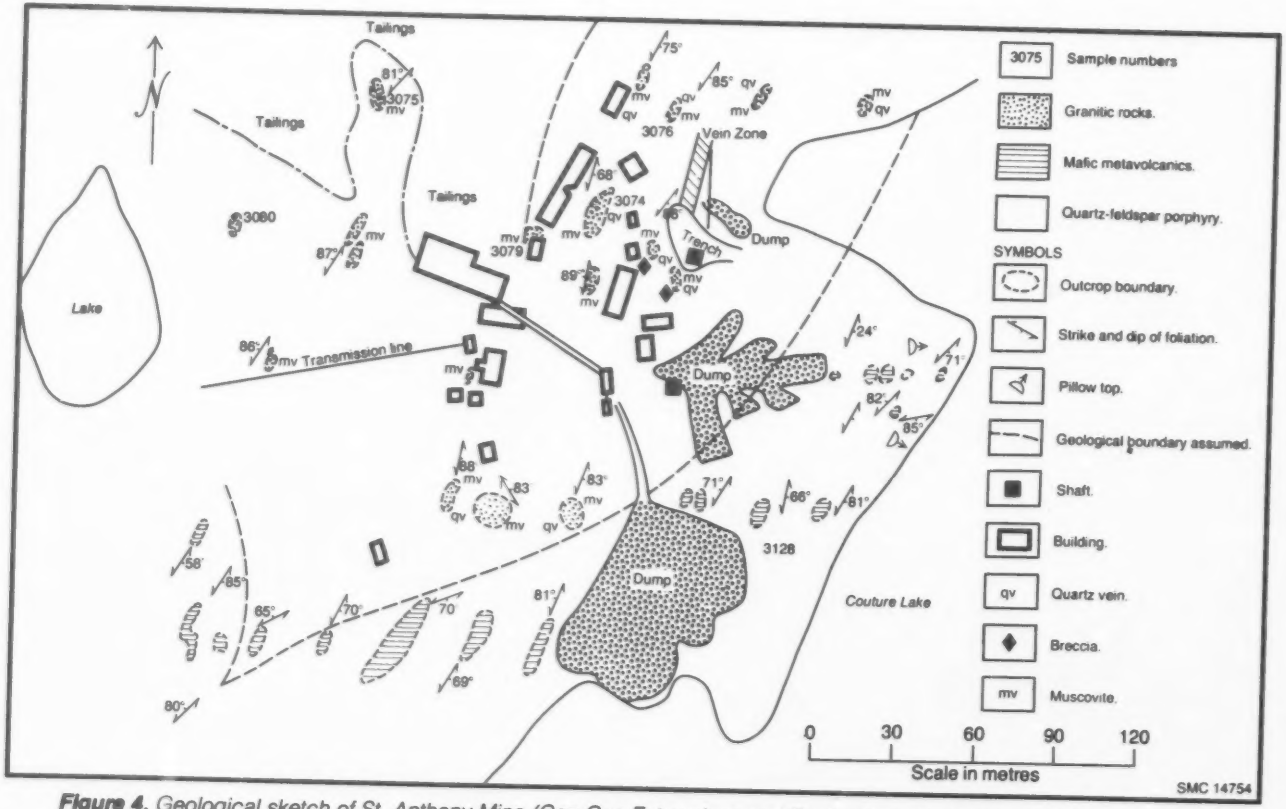


Figure 4. *Geological sketch of St. Anthony Mine (Can-Con Enterprises and Explorations Limited property). Geology by N.F. Trowell.*

TABLE 14. TRACE ELEMENT ANALYSES OF ALTERED ROCKS AT ST. ANTHONY MINE.

Trace Elements	1	2	3	4	5	6
Au (ppb)	30	70	20	30	30	540
Ba	60	40	120	60	50	110
Cu	<5	<5	<5	<5	<5	<5
Cr	<5	<5	<5	<5	<5	<5
Zn	11	8.5	60	8	5	62
Ni	<5	<5	<5	<5	<5	<5
Co	<5	<5	<5	<5	<5	<5
Mo	<2	<2	<2	<2	<2	<2
Sb	<1	<1	<1	<1	<1	<1
As	4	8	<3	7	<3	<3
Ag	<1	<1	<1	<1	<1	<1
Sn	<1	<1	<1	<1	<1	<1
Zr	<10	<10	<10	<10	<10	<10
B	10	20	20	10	<10	20
Pb	<10	<10	<10	<10	<10	<10
W	nd	nd	nd	nd	nd	nd

NOTES

Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto. Analyses in parts per million, except gold in parts per billion.
nd = not detected.

SAMPLES

	Sample No.	Description
1.	T3074	Granodiorite-trondhjemite; medium-grained to slightly quartz porphyritic; 3-5 percent green clotty muscovite, blue-grey quartz; massive, unfoliated.
2.	T3075	Granodiorite-trondhjemite-quartz monzonite; medium-grained, equigranular; massive, unfoliated; 3-4 percent muscovite; 2 percent disseminated sulphide; minor carbonate.
3.	T3076	Granodiorite-trondhjemite, medium-grained, equigranular; massive, unfoliated; 5-8 percent green muscovite; diorite inclusions; Fe stain; minor carbonate.
4.	T3079	Granodiorite-trondhjemite-quartz monzonite; medium-grained, equigranular; leucocratic, minor muscovite; red stain; minor biotite.
5.	T3080	Granodiorite-trondhjemite, medium-grained, equigranular; massive, unfoliated; 5 percent green muscovite.
6.	T3128	Sheared zone in mafic metavolcanics intruded by granitic phase.

CONWEST EXPLORATION COMPANY LIMITED [1971] (7)

In 1970, Conwest Exploration Company Limited held two groups of unpatented claims: (1) 28 claims in the area of King Bay and Sturgeon Narrows, and (2) 21 claims south of King Bay. In 1970 ground magnetic and electromagnetic surveys were conducted over both claim groups. These claim groups were subsequently dropped.

In 1971, Conwest Exploration Company Limited held three groups of unpatented claims: (1) two claims a little over 1.6 km south of the west end of King Bay, (2) 16 claims 1.6 km south of Coveney Lake, and (3) two claims 0.8 km west of the northern tip of the Northeast Arm of Sturgeon Lake. In 1971 Conwest Exploration Company Limited in conjunction with Selco Exploration Company Limited had airborne geophysical surveys conducted over these claim groups. The claim groups were dropped. Claim group 2 was restaked in 1972 by W. Scobie (see below).

No outcrops were found by the field party in the area of claim group 1. Claim group 2 straddles the contact between mafic to intermediate metavolcanics to the north and metasediments to the south. The author has interpreted a sulphide iron formation as extending

through the area. Claim group 3 is underlain by a mixed assemblage of felsic to intermediate pyroclastics and volcanogenic metasediments, intermediate to mafic metavolcanics, and gabbro-diorite intrusions.

C. FORTIER (8)

In 1974, Cyrille Fortier held patented claim BG170, located approximately 1 km northeast of the St. Anthony Mine.

Miller (1903, p.86) described a quartz body on this claim and adjacent area. The quartz vein trends northeast approximately parallel to the strike of the mafic metavolcanic host rocks and contains minor pyrite, chalcopyrite, and tourmaline. Miller reported an assay from this occurrence of $2.75 gold per short ton (gold at approximately $17 per ounce). This quartz body was not found by the field party.

F.H. GRANNIS (SYMMES OCCURRENCE) [1972] (9)

In 1972, Frank H. Grannis held three patented claims (BG137-139) on the east shore of the North Arm of Sturgeon Lake. The ground was open for staking in 1974.

McInnes (1901, p.93) first described what is locally known as the Symmes 'Prospect'. The Symmes occurrence was a narrow quartz vein close to the contact of the granitic rocks with mafic metavolcanics. McInnes reported (1901, p.93) that the mineralization consisted of silver-bearing sphalerite, galena, pyrite, and free gold.

Miller (1903, p.86) and Moore (1911, p.142) reported that the workings on this vein comprised two shafts 25 feet apart, 22 feet and 15 feet deep respectively. The vein was reported to be 9 feet wide and carried pyrite, sphalerite and occasionally visible gold.

Graham (1931, p.50) mentioned that the Huronian Belt Company had prospected the old 'Symmes Prospect'.

L. HANNULA (10*)

In 1974, Leo Hannula held patented claim HW748 located south of Belmore Bay. Moore (1911, p.153) briefly referred to the working on this claim:

> The other company which has done much work in the vicinity of Belmore bay is the Belmore Bay Mining Company, which owns a number of claims just east of the lake. It is said that the shaft near Mud Lake, where the camps are situated, is 260 feet deep, and very little ore came out of it. A three-stamp mill has been erected on the shore of the lake, but it did not run long....

Previous mention to the Belmore Bay Mining Company was made by Corkill (1907, p.60; 1908, p.66; 1909, p.82). He (1909) described the type of quartz vein being worked:

> The gold occurs in a quartz gangue, sometimes intimately associated with galena and zincblende.

No further work is recorded.

S. JOHNSON (11)

Davidson Carr Occurrence

In 1974, S. Johnson held two claims which contained within their boundaries the Davidson Carr Occurrence.

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*Note: this property is labelled incorrectly as 5 on the map-face.

During the winter of 1928-1929, the Golden Centre Mining Company did considerable exploration work on what is locally known as the Davidson Carr 'Mine' (located on the east shore of the Northeast Arm near its north end. Graham (1931, p.49) gave a brief description of this occurrence:

The Davidson Carr mine is situated on claims T.B. 958 and 4,581 at the north end of the Northeast arm. During the winter of 1928-29, the Golden Centre Mining Company carried out considerable exploration work on this property under option. An inclined shaft was put down 165 feet and 150 feet of underground lateral work completed. When the writer visited the property, operations had ceased and the shaft was filling with water.

The main vein follows a drag fold at the contact between Keewatin greenstone and interbanded acid volcanic breccia, rhyolite, and tuff. Quartz porphyry dikes cut through the property. A slight fault occurs at the crest of the drag fold. Apparently the values are confined to the centre of the drag. The vein is 6 feet wide at the top of the shaft and has been traced for 600 feet on the surface. The width of the vein decreases at depth.

Figure 5 is a reproduction of Graham's (1931, p.49) geological map of the occurrence while Figure 6 is a geological sketch map of the occurrence prepared by the field party during the summer of 1973.

Work must have been carried out on this property prior to the activity in the late 1920s as Moore's map (1911) shows a shaft just east of the location of the inclined shaft described by Graham. McRae Mining Corporation Limited held this working in 1970 (see McRae Mining Corporation Limited, below) but no further work was done specifically on this working though airborne magnetic and electromagnetic surveys were conducted over the entire claim group.

Powell Occcurrence

Workings located on the west side of the upper portion of the Northeast Arm of Sturgeon Lake on claims now held by S. Johnson were examined by the field party in 1973. Moore (1911, p.150, 151) referred to workings in the same approximate area, that were located on former patented claim AL701:

On the west shore of Northeast bay, on Claim A.L. 701, there is a deposit locally known as the Powell property. Last summer it was developed for Mr. Beidelman under the management of Mr. Atwood, who was formerly with the Douglas Mining Company. The workings lie on a vein, consisting of attractive-looking quartz, beginning near the lake shore and running a little west of south. There are a number of pits, and two of them were about 25 feet deep, but neither was timbered at the time of our visit. The rocks consist of a complicated mixture of quartz-porphyry, gray schist and greenstone, and the vein lies sometimes in one rock and sometimes in the other, and in places along the contact between the two. It varies in width from 2 to 15 inches, and frequently breaks up into stringers, especially at the contact between different types of rock. The quartz is well mineralized with pyrite and chalcopyrite, the latter frequently altered to malachite and azurite. We had no difficulty in finding good samples of gold at a depth of 20 feet. These gold specimens are doubtless due to the secondary enrichment process, as they occur in association with the secondary carbonates of copper.

Near the pits described there are a number of smaller ones on this same vein, which fingers out a little farther south.

Figure 7 is a geological sketch map of the workings assumed to be the same as those described. A grab sample of mineralized rock from the dump was collected by the field party. Analysis by the Geoscience Laboratories, Ontario Geological Survey indicated the presence of appreciable trace element contents of Au (several hundred ppb) and Cu (in excess of one percent).

KERR ADDISON MINES LIMITED [1972] (12)

In 1972 Kerr Addison Mines Limited held a group of 16 unpatented claims approximately

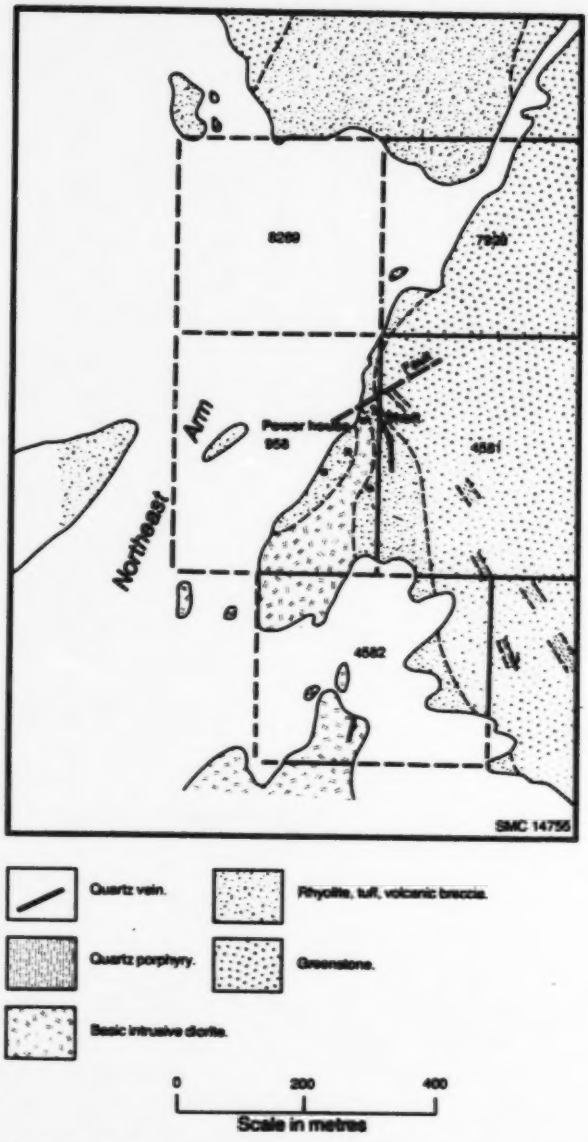

Figure 5. Geological sketch map of the Davidson Carr occurrence from Graham (1931).

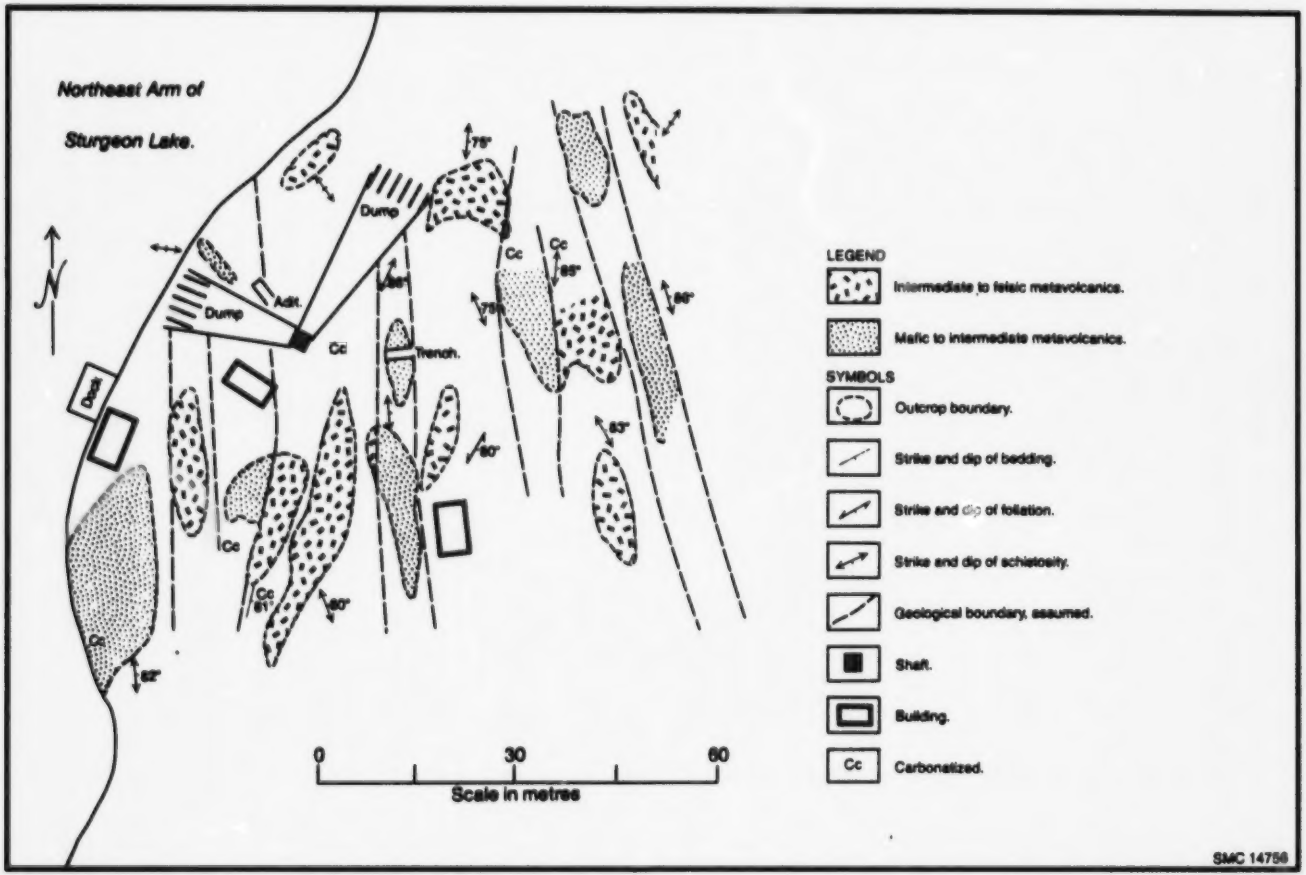

Figure 6. *Geological sketch map of Davidson Carr occurrence. Geology by N.F. Trowell.*

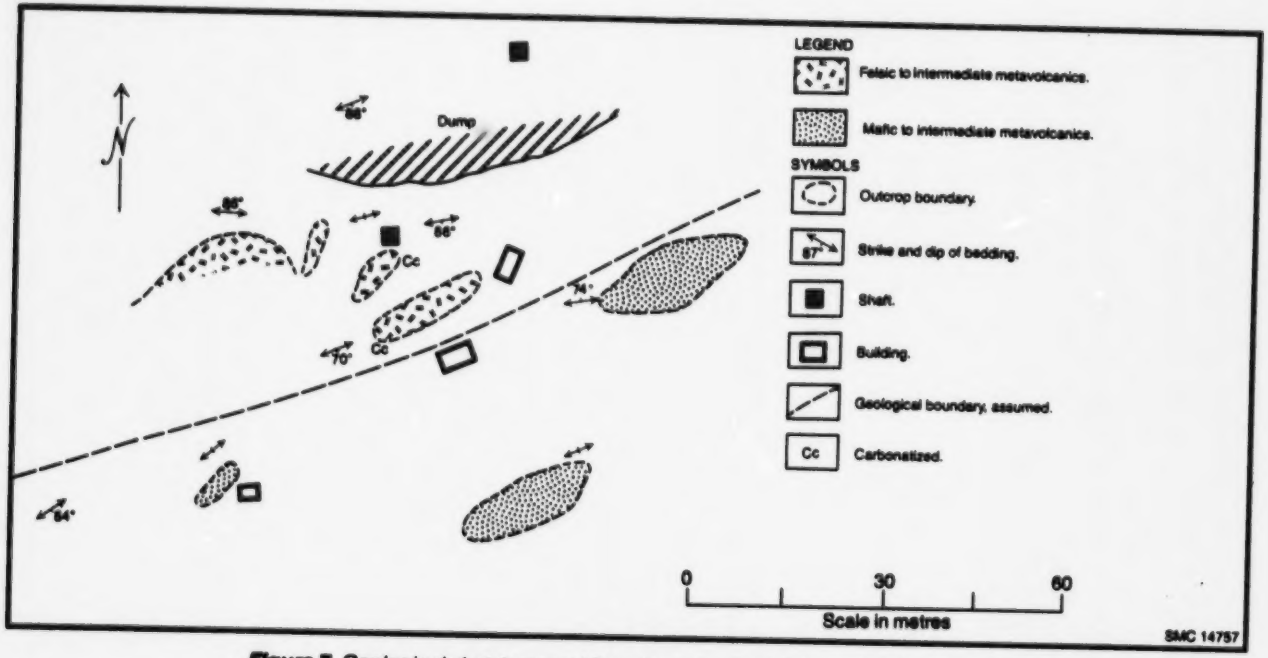

Figure 7. *Geological sketch map of Powell occurrence. Geology by N.F. Trowell.*

2.5 km east of the northern tip of Morgan Island. In 1972, they conducted ground magnetic and electromagnetic surveys over the claim group. Claims were subsequently dropped.

The property is underlain by an intercalated assemblage of intermediate to mafic amygdaloidal pillowed flows and felsic to intermediate pyroclastic rocks both intruded by sills, dikes, and irregular masses of gabbro, diorite, and feldspar-porphyritic gabbro-diorite.

D. KOVAL (ANGLO CANADIAN OCCURRENCE) (13)

In 1974, Donald Koval held three claims under lease. These claims, 3 km south of the north end of Northeast Arm, include portions of former patented claims FM206-207, the workings on which have been previously described by McInnes (1901, p.94) and Coleman (1902, p.149). Miller (1903, p.87) described it:

Two or three claims were examined on the northeast bay or arm of Sturgeon Lake. On location F.M. 207, the property of the Anglo Canadian Gold Estates, the strike of the quartz vein is N.10°E., and the dip, where it can be determined, is to the westward. Stripping and other work has been done along the vein at points for a distance of about 300 feet. A shaft, 6 x 8 feet, has been sunk at one point. As it was filled with water we did not learn its depth. The vein lies in chloritic schist which is in contact, near the south end of the vein, with what appears to be squeezed quartz porphyry. The body of quartz is more vein-like near the shaft. At other points it has the appearance of being a somewhat irregular segregation in the schist. The minerals associated with the quartz consist of small quantities of pyrite, copper pyrites and dolomite.

In 1934, Richelieu Gold Mines Limited acquired the ground in this area, covering the above described workings, from Golden Spur Syndicate Limited. Sinclair (1939, p.153-154) described the workings on this property:

On the main group, a 2-compartment shaft was started in December, 1934. By the end of 1934 it had reached a depth of 115 feet. Sinking continued in 1935 to a depth of 278 feet. Levels were established at 125 and 250 feet and exploration by drifting was actively carried on to September 17, 1935, when the mine was closed down.

Ouillette Mines Limited subsequently acquired the property in 1946-1947 and re-examined five claims of the former Richelieu claim group. These five claims contain the main workings of Richelieu Gold Mines Limited within their boundary.

Consulting geologist T.L. Gledhill prepared a geological report (available in the Assessment Files Research Office, Ontario Geological Survey, Toronto) on these claims, the report being acquired by Ouillette Mines Limited:

The main vein developed so far is located near the centre of claim F.M.208. This vein lies west of a large dike of acid porphyry. Trenching has exposed the vein at intervals for several hundred feet. The general strike of the vein is north 25 degrees east and the dip is about 60 degrees to the northwest. The average width on surface of the main vein is about 2 feet.

150 feet northwest of the north end of the main vein another vein has been uncovered, and also several others in various parts of the claims.

The main vein had been opened up by cross-trenches spaced along it at intervals and by two deep pits. The new vertical shaft is located on the hanging wall side of the main vein 112 feet west of the vein outcrop. The shaft has two compartments. The present depth is 157 feet. A station and level was established at 125 feet. From here a cross-cut was run for 133 feet to the east. The vein was cut 37 feet east of the shaft and then drifted on to the north and south. Following the vein north it maintained a 4-foot width for 30 feet from the cross-cut and showed a sparse mineralization by sulphides. From here to the north end of the drift the vein was ill-defined and the quartz acted more as a filling to a coarse breccia. Drifting south on the vein from the cross-cut the vein continued for 10 feet and then narrowed to a few inches. From here the south drift was turned to the east and the vein was picked up, widening to four and five feet of vein quartz with parallel bands of tourmaline showing more prominently, the walls of the vein were better defined and sulphides were commoner. Drifting was being continued to the southeast to get under the good ore section of the vein sampled on surface. There is no reason why the good ore found on surface should not be found on the 125-foot level. The vein will probably continue southeast on the 125-foot level until it reaches the porphyry dike and may then swing and follow the porphyry greenstone contact.

Structure and Mineralogy of the Main Vein:

The gold veins are of the fissure type with the gold values in the vein quartz which has distinct walls. On surface the hanging or foot-wall position in the vein appears to be richer in gold. Near the vein walls a ribbon structure, of parallel bands of black tourmaline, is common. This feature is seen in the better vein sections. In the richer sections the vein walls appear to have been more readily sheared and the greenstone finer grained.

The vein minerals besides quartz, are tourmaline, ankerite, chalcopyrite, pyrite, and native gold. Chalcopyrite is more plentiful than pyrite. In a number of places free gold is seen in or near slips in the thin seams of black tourmaline found in the quartz. The quartz is of a light gray colour and of medium texture.

In 1960 Cromorr Mines Limited, which had acquired the occurrence, carried out a program of diamond drilling to test for downward extensions of the gold-bearing veins.

B. KRATZENDEIN (14)

In 1974, Benjamen Kratzendein held a group of five patented claims (AL656-659, HW686) east of Couture Lake across from the St. Anthony Mine.

Moore (1911, p.149, 150) referred to the workings on claims AL656-657:

On claims A.L. 656 and 657 there are a number of pits and one shaft. These are controlled by Messrs. King and Frazer. The shaft is said to be 75 feet deep. The vein of quartz and calcite is about 8 inches wide, and has a pretty distinct hanging wall. It carries some nice specimens of visible gold. The vein can be followed over a portion of two claims, and although it is largely in green schist it is closely associated with a narrow band of comparatively fresh-looking quartz-porphyry, in which is some of the quartz, and some of it along the contact between it and the schist. The vein shows a tendency to break up into stringers in some places, and is small, although the quartz looks favorable as a carrier of gold.

Miller (1903, p.86) made brief reference to claim HW686, but no details were given.

LARCHMONT MINES LIMITED [1971] (15)

In 1971, Larchmont Mines Limited held a group of 50 unpatented claims south and west of King's Bay. In 1971 they conducted airborne magnetic and electromagnetic surveys over the claim group. In 1947, a diamond drill hole with a length of 46 m was drilled by persons unknown on this claim group, known then as the 'Anderson Group'. The drill hole intersected mafic metavolcanics (Assessment Files Research Office, Ontario Geological Survey, Toronto). The claims were subsequently dropped.

The former property is underlain by a predominantly mafic metavolcanic assemblage containing thin intercalated felsic to intermediate pyroclastic units and intruded by gabbro-diorite bodies.

MATTAGAMI LAKE MINES LIMITED (16)

In 1974 Mattagami Lake Mines Limited held a group of 28 unpatented claims north of King Bay.

In 1946, Hans Lundberg, acting on behalf of C.J. Ryan and Associates who at that time controlled a portion of this property, conducted ground magnetic, electromagnetic and self potential, and geological surveys over the claim group. Subsequently in 1946 and 1947, 11 diamond-drill holes with a total length of 809.8 m were put down to test the geophysical anomalies and surface showings. Several bluish quartz veins within the predominantly mafic to intermediate metavolcanic assemblage are reported to have contained from 0.04 to 0.08 ounces Au per ton.

In 1969 Mattagami Lake Mines Limited conducted airborne electromagnetic, ground

magnetic and electromagnetic, and geological surveys over the property. In 1971, they carried out a further ground electromagnetic survey.

The property is predominantly underlain by an assemblage of mafic to intermediate metavolcanic and intrusive rocks with minor intercalated units of felsic to intermediate tuff, and intrusive quartz-feldspar trondhjemite porphyry.

MCRAE MINING CORPORATION LIMITED [1970] (17)

In 1970, McRae Mining Corporation Limited held a group of 35 unpatented claims at the northern end of the Northeast Arm of Sturgeon Lake.

In 1970, they conducted airborne magnetic and electromagnetic surveys over the claim group. The claims were subsequently dropped.

The claim group is underlain to the west by an intercalated assemblage of felsic to intermediate pyroclastics, mafic to intermediate flows, and diorite, gabbro, and feldspar-porphyritic gabbro intrusions, while to the east it is underlain by mafic to intermediate amygdaloidal and pillowed flows and thin interflow units of felsic to intermediate pyroclastics. This claim group included within its boundaries the old Davidson Carr occurrence (see 'S. Johnson').

K. O'FLAHERTY (18)

In 1974, K. O'Flaherty held a claim (formerly patented claim TB34310) located approximately 1 km northwest of the junction of the North Arm and Northeast Arm of Sturgeon Lake.

As reported by Moore (1911, p.141, 142) and (Corkill 1912, p.103) a 50-foot deep shaft with 20 feet of drifting and cross-cutting was sunk on a group of quartz veins that intrude mafic metavolcanics cut by intrusive trondhjemite. Moore (1911, p.141, 142) reported that the quartz from the shaft gave gold values but no visible gold was seen.

OMAR EXPLORATION INCORPORATED [1970] (19)

In 1970 ground magnetic and electromagnetic surveys were conducted over two groups of unpatented claims: (1) 41 claims over and east of northern portion of Vanessa Lake, and (2) 18 claims east of Vista Lake centred on the Flindt River. These claims were subsequently dropped.

The two claim groups are underlain predominantly by amphibolite facies metavolcanics and metasediments which contain intercalated units of sulphide (pyrite + pyrrhotite + graphite) iron formation.

PHELPS DODGE CORPORATION OF CANADA LIMITED (20)

In 1971, Phelps Dodge Corporation of Canada Limited held a group of 49 unpatented claims east and northeast of the Northeast Arm of Sturgeon Lake. In 1971, they carried out a ground magnetic survey over the claim group. These claims were dropped.

The former claim group is underlain predominantly by mafic to intermediate metavolcanics with minor interflow felsic to intermediate pyroclastics. Both lithologies are intruded by sills, dikes and irregular masses of gabbro and diorite.

In 1974, Phelps Dodge Corporation of Canada Limited held a group of 80 unpatented claims in the area of Morgan Island.

In 1973, they conducted ground magnetic and electromagnetic surveys over the Morgan Island claim group. A portion of this property was covered by ground magnetic and electromagnetic surveys during 1970 when the claims concerned were held by Arthur Theriault (see below).

The claim group is underlain by a felsic to intermediate pyroclastic assemblage containing thin intercalated mafic to intermediate metavolcanic flows. Gabbro-diorite intrusions are abundant. This property partially covers the carbonate breccia map-unit, which has a distinct magnetic response due to its high content of Fe-Ti oxides (see "General Geology").

POMAC MINES LIMITED (21)

In 1974 Pomac Mines Limited held a property, the Dawson-White occurrence, comprising nine patented claims: BG155 (TB6982), BG156 (TB6981), BG157 (TB6980), BG158 (TB6979), BG159 (TB6977), HW696-698, and the southwest portion of HW705 (TB6978) including one patented fraction (La Riviere) located on the east side of the North Arm of Sturgeon Lake, about 1.6 km northeast of the St. Anthony mine.

The Dawson claims (BG155-159) were first worked by the Sturgeon Lake Mining Company Limited, who acquired them in 1901. According to McInnes (1901, p.93) the initial workings were on a north-northeast trending gold-bearing quartz vein. The east location is commonly known as the White 'Prospect'.

According to Carter (1901, p.103; 1902, p.149) and Coleman (1902, p.256) the workings on the main quartz vein comprised a 55-foot shaft, an open cut, and some test pits. The quartz veins conformably cut the mafic metavolcanics. They contained galena, sphalerite and pyrite; native copper and free gold were also reported.

In 1902 the English River Gold Mining Company Limited was incorporated to take over the Dawson claims. Miller (1903, p.84, 85) gave a brief description of the Dawson occurrence:

> The workings consist of a shaft 64 feet deep, and an open cut, near the shaft, which has a length of 70 feet and an average depth of about 10 feet, following the vein. Several pits have been put down and stripping has been done on other parts of the locations.
>
> At the point where the most work has been done the strike of the vein is approximately parallel with dikes of granite which cut through the green schist of the neighbourhood. The vein lies in the schist and dips to the eastward or away from the lake at an angle of about 65°.
>
> Some rich specimens of gold in quartz are found in the shaft and open cut. Associated minerals are pyrite, galena, blende, and a little copper in the native state.

According to Miller (1903, p.85) the White 'prospect' consisted of a 15 to 20 ton gold-bearing boulder of quartz.

Moore (1911, p.148, 149) described the Dawson and White occurrences:

> On location B.G. 157 is what is known as the Dawson mine, now owned by the English River Gold Mining Company, and formerly controlled by the Sturgeon Lake Mining Company. Like the St. Anthony, it is situated near the contact between the green schists and granite, but instead of lying on the main contact, it lies on the contact between bands of schist and arkose cut by the granite. There are here a number of pegmatite dikes, in some parts composed of about half feldspar and half quartz, and in other parts consisting largely of one or the other.
>
> The gangue is quartz, and the ore minerals found were galena, sphalerite, pyrite and chalcopyrite. Good specimens of free gold are said to have been found, though we were unable to find any on the dump.
>
> .... On claim H.W. 697, southeast of the Dawson mine, known as the 'White Prospect' there is a mass of quartz broken up by prospectors. This large mass appears to have been separated from a vein somewhere in the vicinity and was probably moved to its present position by a glacier. It is very difficult to say where the mass originated, and it seems to lie on green schist. There is swamp to the

north and west. As there is a large vein whose strike would carry it through this swamp, lying about 100 paces to the southwest, it is probable that the mass of quartz has been broken from this vein a little to the north. The vein where exposed is about 15 feet wide, and consists of what appears to be barren white quartz. The broken quartz looks more favourable as a carrier of gold, and although two of us on two separate occasions spent considerable time in searching the fragments for specimens, we were unable to find any visible gold. Dr. W.G. Miller in his report on this prospect states that he had no difficulty in finding 'shows of gold', and apparently the attractive specimens have all been carried away.

In 1936 Dawson-White Gold Mines Limited was incorporated acquiring the Dawson claims and the adjoining White and La Riviere properties. Sinclair *et al.* (1939, p.111, 112) described the new development of the property:

On May 23 the sinking of a 2-compartment, vertical shaft was commenced about 140 feet northeast of the old workings.

Sinking under power was commenced on June 11, and the shaft was sunk to a depth of 220 feet, with 80 feet of crosscutting, 190 feet of drifting, and 30 feet of raising on the 100-foot level, and 85 feet of drifting on the 200-foot level.

During the period of operations there were 16 men employed, of whom 8 were underground, under the direction of D.M. McLarty.

In September, 1939, Dawson Gold Mines Limited acquired the claims but was declared bankrupt the following year before completion of any work. The property was sold to private interests who held it until February, 1964, when it was purchased by Pomac Mines Limited.

In a prospectus filed with the Ontario Securities Commission, Pomac Mines Limited outlined the work they had carried out on this property in 1965. This included reopening and resampling of some of the old pits on the Dawson and La Riviere locations, dewatering and trenching of the old open cut and trenches on BG157 and HW697, and magnetic and electromagnetic surveys over portions of the property.

E.R. ROWLAND (22)

In 1974, Eugene R. Rowland held three groups of patented claims: Group 1 comprising eight claims, AL635 (P7), AL636 (TB7), AL637 (P8), AL638 (TB943), SV392, SV399 (TB5, TB6), FM204, and FM205 (P6), east of Belmore Bay; Group 2 comprising one claim, AL497, on the east shore of the North Arm of Sturgeon Lake; and Group 3 comprising two claims, TB1352 and TB1353, east of Ouilette Lake. He also held one unsurveyed claim southeast of Belmore Bay.

On Group 1, according to Moore (1911, p.151), two shafts were sunk on claim P7, one 22 feet deep, the other 73 feet. Quartz samples from the deeper shaft contained chalcopyrite and pyrite.

According to Moore (1911, p.142, 143) the workings on Group 2 comprised three pits sunk on an irregular quartz mass near the granitic rock-mafic metavolcanic contact. Moore (1911, p.142, 143) reported that the quartz mass was fairly well mineralized with chalcopyrite and pyrite and that selected samples had contained silver, gold, and copper assay values.

Moore (1911) found the shaft (not located by field party) of the Northern Light 'Mine' on Group 3 to be flooded. The vein is not exposed on surface but quartz samples from the dump contained minor pyrite and chalcopyrite. A pit just west of the shaft exposed dioritic and schistose rocks cut by a 6-foot wide quartz vein.

ROYEX MINING LIMITED [1972] (23)

In 1970, Royex Mining Limited conducted ground magnetic and electromagnetic surveys over four groups of unpatented claims: (1) 40 claims north of Squaw Lake registered in the

name of Sturgex Mines Limited, (2) 50 claims on and east of the northern part of Vanessa Lake, (3) 74 claims on and west of Vista Lake registered in the name of Sturgex Mines Limited, and (4) 76 claims on and east of Vista and Vanessa Lakes.

In 1971, ground magnetic and electromagnetic surveys were conducted over three groups of unpatented claims: (1) 18 claims northeast of Vista Lake, (2) 13 claims east of Vista Lake and (3) 3 claims east of the central portion of Vanessa Lake.

In 1972, ground magnetic and electromagnetic surveys were conducted over a group of 12 unpatented claims approximately 1.2 km southeast of Magee Lake. In 1972, one diamond drill hole with a length of 94.8 m intersected an assemblage of intermediate metavolcanic flows and pyroclastics with narrow argillite zones containing disseminated pyrite-pyrrhotite mineralization.

These claims were subsequently dropped.

W. SCOBIE [1972] (24)

In 1972, ground magnetic and electromagnetic surveys were conducted over a group of 16 unpatented claims approximately 1.6 km east of Magee Lake. In 1971, Conwest Exploration Company Limited conducted airborne magnetic and electromagnetic surveys over this claim group. These claims were subsequently dropped.

The claim group is underlain by mafic to intermediate metavolcanics and metasediments containing discrete units of sulphide facies iron formation.

SELCO EXPLORATION COMPANY LIMITED [1970] (25)

In 1970, Selco Exploration Company Limited held five groups of unpatented claims: (1) 99 claims on the peninsula between the North Arm and Northeast Arm of Sturgeon Lake, (2) 15 claims in the area of King Bay, (3) 59 claims in East Bay, (4) 11 claims towards the north end of Couture Lake, and (5) 28 claims on Couture and Ouilette Lakes. The claim groups were subsequently dropped.

Group 1. In 1970, Selco Exploration Company Limited conducted ground magnetic and electromagnetic surveys over this claim group. Eleven diamond drill holes with a total length of 1196 m were drilled in 1970 to test the geophysical anomalies picked up during the surveys. The diamond drill holes near the east shore of North Bay intersected a predominantly mafic metavolcanic/intrusive assemblage with minor intercalated units of felsic to intermediate tuffs, porphyries, and argillaceous metasediments. The drill holes in the middle of the peninsula and near the Northeast Arm intersected an intercalated assemblage of mafic to intermediate metavolcanics, felsic to intermediate pyroclastics, porphyries and local graphitic argillaceous metasediments or tuffs containing pyrite-pyrrhotite mineralization. Chalcopyrite locally accompanies the pyrite and pyrrhotite while sphalerite was identified in drill core from one hole.

Group 2. Selco Exploration Company Limited conducted ground electromagnetic surveys over this claim group in 1971. The claim group is underlain predominantly by mafic to intermediate metavolcanics with thin intercalated felsic to intermediate metavolcanic units and intrusive quartz-feldspar trondhjemite porphyry.

Group 3. In 1970, Selco Exploration Company Limited carried out ground magnetic and electromagnetic surveys over this claim group. Two diamond drill holes with a total length of 223 m were put down in 1970 to test the geophysical anomalies. The drill holes intersected a predominantly metasedimentary assemblage of wacke, siltstone-argillite, and minor conglomerate. Banded or bedded sulphide (pyrite-pyrrhotite) zones were intersected, intercalated within the metasediments. Locally, sulphide concretions comprising a central core of pyrrhotite surrounded by fine concentric pyrrhotite and pyrite rings, were reported in these sulphide-rich (sulphide iron formation) zones.

Group 4. In 1970, Selco Exploration Company Limited conducted ground magnetic and electromagnetic surveys over this claim group. This former claim group is underlain by mafic metavolcanic, predominantly pillowed, flows, gabbro-diorite intrusions, and thin interflow units of intermediate tuff.

Group 5. In 1970, Selco Exploration Company Limited conducted a ground electromagnetic survey over the claim group. One diamond drill hole with a length of 40.2 m was put down to test a geophysical anomaly. The drill hole intersected a predominantly mafic to intermediate metavolcanic assemblage with thin intercalated units of felsic to intermediate tuff and local zones showing concentrations of pyrite and pyrrhotite.

SILVERSIDE MINES LIMITED [1971] (26)

In 1971, Silverside Mines Limited held a group of 31 unpatented claims at the west end of King Bay.

In 1970, they conducted airborne electromagnetic and magnetic surveys over the claim group. In 1971, they carried out a geological survey of the claim group. In 1973, they drilled three diamond drill holes with a total length of 183 m to test the geophysical anomalies. The three drill holes intersected a mafic metavolcanic assemblage containing local carbonatized and mineralized (pyrite, pyrrhotite) zones.

These claims were subsequently dropped.

SPOONER MINES AND OILS LIMITED [1972] (27)

In 1972 Granges Exploration Aktiebolag held a group of 65 unpatented claims under option from Spooner Mines and Oils Limited, northwest of King Bay. In 1970, Spooner Mines and Oils Limited conducted an airborne magnetic and electromagnetic survey over the claim group. In 1971, they carried out ground magnetic and electromagnetic surveys over the claim group. In 1972, Granges Exploration Aktiebolag carried out a ground electromagnetic survey over the property. The claims were dropped.

The former claim group is underlain by a mafic metavolcanic and amphibolite assemblage in contact with marginal granodiorite and trondhjemite phases of the western granitic complex in the northeast corner of the claim group.

STEEP ROCK IRON MINES LIMITED (28)

In 1974, Steep Rock Iron Mines Limited held two groups of patented claims, one comprising seven patented claims (AL367-373) along the south shore of King Bay, the second comprising six patented claims (BG128, BG129, BG134-136, BG149) on the southwest shore of the North Arm of Sturgeon Lake.

The property at the south shore of King Bay has been described by Davidson (1901, p.247), Coleman (1902, p.256), Miller (1903, p.85), and Moore (1911, p.140, 141).

The workings on this property comprise three shafts and a combined open cut and tunnel, and were described by Moore (1911, p.140, 141).

Shaft No. 1 near the mill was said to have a depth of 100 feet, and No. 3, near the water's edge, 60 feet. There was a combined open cut and tunnel which ran about 125 feet N. 60°W. into the hill side. No. 2 shaft, which lies back on the hill, was 70 feet deep, but had been abandoned.

The field party visited this property in the summer of 1972. Near the water's edge a thin (less than 1.5 m) siliceous sulphide (pyrite, pyrrhotite) bearing unit is confined between two pillowed mafic metavolcanic flows. This unit is traceable for approximately 60 m along the water's edge and near the shaft closest to the water is irregularly intruded by quartz-

feldspar trondhjemite porphyry. The open cut and tunnel appear to have followed a silicified and slightly carbonatized zone in a mafic volcanic flow or intrusion.

The field party also visited the second property and the observations coincided with those of Miller (1903, p.85, 86), and Moore (1911, p.141) who reported:

> The workings on Claim B.G. 136 consist of a tunnel which runs horizontally not far below the surface, along a vein for a distance of about 150 feet, making a bend to the north about 100 feet from the exit. The vein is quite irregular, and is in the porphyritic granite not far from the contact with greenstone. The gangue is quartz, and carries some pyrite and a little chalcopyrite, partly altered to malachite. The quartz was dark, slightly opalescent, and does not look unfavourable, though no free gold was seen.

The discrepancy between the location of the second prospect as given by Miller (claim BG135) and Moore (claim BG136) might reflect the fact that the workings are on the shoreline, close to the boundary line between the two claims.

M. STEINE (29)

In 1974, M. Steine held two patented claims, AL667 (TB211) and AL666 (TB210), on the east shore of the North Arm of Sturgeon Lake and west of the north end of Couture Lake. To the south, AL666 adjoins TB953 belonging to H.W.W. Bucke (see above). A shaft was found on claim AL666; it appears to be located on the same quartz vein zone as is the shaft on Bucke's claim.

STURGEX MINES LIMITED [1972] (30)

In 1970, ground magnetic and electromagnetic surveys were conducted over a group of 47 unpatented claims north of Vanessa Lake. In 1970, 12 diamond drill holes with a total length of 1220.2 m were put down to test the geophysical anomalies resulting from the survey. The drill holes intersected a predominantly mafic to intermediate metavolcanic and amphibolite assemblage with minor intercalated units of siliceous tuff, graphitic tuff/metasediment, and granitoid intrusive rocks towards the eastern portion of the claim group. Graphitic pyrite-pyrrhotite zones intersected in the drill holes are the probable cause of the anomalies.

In 1972, ground magnetic and electromagnetic surveys were conducted over a group of 80 unpatented claims on and west of Vista Lake. In 1972, four diamond-drill holes with a total length of 358 m were put down to test the geophysical anomalies. The drill holes intersected an assemblage of intermediate metavolcanic and pyroclastic rocks containing thin intercalated units of felsic to intermediate pyroclastic rocks and siltstone-argillite.

The claims were subsequently dropped.

TAY RIVER MINES LIMITED [1971] (31)

In 1971, Tay River Mines Limited held a group of 26 unpatented claims approximately 0.8 km east of the north part of Squaw Lake.

In 1971, they conducted a ground electromagnetic survey over the property and, subsequently, in the same year they drilled four diamond drill holes with a total length of 158 m to test the electromagnetic anomalies The diamond-drill holes intersected a predominantly mafic to intermediate metavolcanic assemblage with intercalated units of metasediments, tuff, porphyry and pyrite-pyrrhotite. The pyrite-pyrrhotite zones were likely the cause of the electromagnetic anomalies.

Claims were subsequently dropped.

A. THERIAULT *ET AL.* [1970] (32*)

In 1970, Arthur Theriault, Frank Theriault, Albert Theriault, A. Chartrand, Andre Cote, and Canex Aerial Exploration Limited held a group of 146 unpatented claims on and north of Morgan Island.

In 1970, they conducted ground magnetic and electromagnetic surveys over the claim group. In 1970, they drilled two diamond drill holes with a total length of 430.1 m to test the geophysical anomalies. The drill holes intersected a mixed assemblage of felsic to intermediate metavolcanics, mafic to intermediate metavolcanics (chlorite schist), gabbro intrusions and rare mineralized zones containing disseminated pyrite and locally minor chalcopyrite.

The claims were dropped. A portion of this former property was held in 1974 by Phelps Dodge Corporation of Canada Limited (see above).

UTICA MINES LIMITED [1970] (33)

In 1970, ground electromagnetic surveys were conducted over two groups of unpatented claims: (1) 17 claims at the north end of Vanessa Lake, and (2) 9 claims over the central portion of Vanessa Lake. The claims were dropped.

The two former claim groups are underlain predominantly by amphibolite facies metavolcanics and metasediments.

WESTERN QUEBEC MINES COMPANY LIMITED [1971] (34)

In 1971, Western Quebec Mines Company Limited held a group of 22 unpatented claims southeast of Coveney Island.

In 1971, they conducted an airborne magnetic and electromagnetic survey and carried out a ground program of rock sampling and geological mapping over this claim group. Two diamond drill holes, with a total length of 302 m, put down to test geophysical anomalies, intersected a predominantly metasedimentary assemblage with minor intercalated mafic metavolcanics. Graphitic pyrite-pyrrhotite zones intercalated in the metasedimentary assemblage were probably the cause of the geophysical anomalies. The claims were dropped.

This former property comprises an area underlain from west to east by a portion of the syenogabbro-syenodiorite zone of the Sturgeon Narrows Alkalic Complex, mafic to intermediate metavolcanics, and metasediments. The metasediments that border the Sturgeon Narrows Alkalic Complex have been weakly to moderately fenitized and intruded by aplosyenite-aplomonzonite veins and dikelets.

MISCELLANEOUS OCCURRENCES

Moore (1911, p.151) mentioned pits on quartz veins "on the long point running south, just west of the island covered by S.V. 414" approximately 2.8 km north of Nipigon Bay. Moore (1911, p.151) reported that these pits were on irregular quartz veins in quartz porphyry or at quartz porphyry-mafic metavolcanic contacts. He mentioned that local concentrations of pyrite occur in these veins and that free gold was observed but gave no analyses or assay values.

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*Note: this former property is labelled incorrectly as **22** on the map-face.

Moore (1911, p.150) also referred to a shaft and workings on former patented claim AL662 situated 3.2 km northeast of the St. Anthony Mine. This shaft, having a depth of at least 20 feet was put down on a narrow quartz vein having a footwall of schist and a hanging wall of altered wacke. The vein contains chalcopyrite, galena, sphalerite, pyrite, and a little pyrrhotite. Moore (1911, p.150) reported the presence of free gold but gave no assay values.

Other occurrences are referred to in the literature but their locations could not be determined and so they have not been discussed here.

Considerations in Future Exploration

Although no economic mineral deposits have yet been found in the Squaw Lake-Sturgeon Lake area, with the exception of St. Anthony Mine, the mineral exploration potential of the area is relatively high. Not only is this area in close proximity to the massive sulphide deposits of the Sturgeon Lake metavolcanic-metasedimentary belt (see Table 1), but as well it has numerous mineralized zones and favourable lithology and stratigraphy. Between 1905 and 1941, gold and silver valued at $2,165,292 were mined from the St. Anthony Mine.

The volcanic succession is lithologically and stratigraphically similar to that present in the south Sturgeon Lake area where massive sulphide deposits are located (see Trowell 1974a,c). In the present map-area a series of felsic to intermediate, dominantly pyroclastic assemblages (B, E, and F) are separated by mafic to intermediate metavolcanic assemblage D. The individual felsic to intermediate assemblages are multicyclic in nature, comprising alternating units of intermediate and felsic volcanic fragmental rocks and intermediate and mafic volcanic interflows. In the Morgan Island area especially, assemblage B appears to reflect the buildup of a differentiated volcanic pile with the composition becoming gradually more felsic towards the top of the succession, which is dominated by coarse pyroclastic material. This assemblage is apparently overlain by mafic to intermediate assemblage D characterized by mainly amygdaloidal pillowed flows and local zones of pillow breccia suggestive of a shallow subaqueous environment. Chloritoid has been locally developed in these rocks (see "General Geology"). Although no concentrations of chloritoid comparable to that of the footwall alteration zone of the Mattabi Mines Limited orebody were observed, its presence in a similar metamorphic mineral assemblage derived from felsic to intermediate pyroclastic rocks is suggestive of comparable rock suites in the two areas.

While some of these units appear to have been subaqueously reworked and redeposited they still constitute proximal facies volcanic fragmental rocks and thus probably are close to the source area and still favourable for exploration.

The main hindrance to exploration in the immediate area of the Northeast Arm is the fact that the majority of the rock units are underwater, and thus it is difficult to correlate geophysical data with surficial geology. Exploration in this area as well as including conventional ground magnetic and electromagnetic surveys could possibly involve detailed geological mapping, rock geochemistry, and biogeochemistry of the vegetation on the islands along the Northeast Arm.

The other felsic to intermediate metavolcanic assemblages (E and F) should not be ignored but should be prospected perhaps using the same methods as outlined above.

Any occurrences of exhalative units — graphitic sulphide zones, pyrite-pyrrhotite zones, stratabound carbonate-sulphide zones — intersected in any future diamond drill holes in these assemblages should be geochemically tested for base and precious metal trace element abundances.

The stratigraphic position of the pyroclastic units is perhaps one of the determining factors in whether or not they contain significant amounts of trace and precious metals; that

is, the closer these units lie to any original volcanic center the more probability that they could contain significant base and precious metals, providing of course the metals were available.

The carbonate breccia unit might be amenable to whole rock geochemical surveys to determine the distribution and any possible concentrations of these elements.

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INDEX

Aegerine-augite needles
Squaw Lake Alkalic Complex 60
Trachytoidal texture 69
Aeromagnetic data 67
Squaw Lake Alkalic Complex 60
Sturgeon Narrows Alkalic Complex 73
Vista Lake Intrusion 51
Agglomerate
Intermediate lapillistone 40
Photo 41
Agmatite zone
Vanessa Lake Intrusion 53,54
Alkalic phase
Squaw Lake Alkalic Complex 60-61,65
Allanite
Granodiorite-monzonite 52
Amax Expl. Inc. 78,81
Amphibole
Gabbro-diorite 44
Gabbroic rock 57
Metasediments 57
Amphibolite 6,17-18
Inclusions 49
Amphibolite facies
Boudinage structure 69
Eastern Granitic Complex 49
Gabbro-diorite 44
Gneissic structure 68
Mafic to intermediate metavolcanics 18
Western Granitic Complex 49-50
Amygdules
Carbonate breccia 32
Mafic intrusive rocks 43
Mafic to intermediate metavolcanics 16
Analyses, chemical
Major elements
Carbonate breccia 34
Diorite 46
Gabbro 46
Granodiorite 84
Greenstone schist 83
Metavolcanics 10
Rusty weathering biotite schist 83
Sericite schist 84
Squaw Lake Alkalic Complex 62
Sturgeon Narrows Alkalic Complex 58
Vanessa Lake Intrusion 54
Normative Minerals
Diorite 46
Gabbro 46
Metavolcanics 12
Squaw Lake Alkalic Complex 64
Sturgeon Narrows Alkalic Complex 58
Vanessa Lake Intrusion 54
Trace Elements
Carbonate breccia 34,35
Diorite 46
Gabbro 46
Granodiorite-trondhjemite 86
Granodiorite-trondhjemite-quartz monzonite 86
Metavolcanics 11
St. Anthony Mine 86
Shear zone in mafic metavolcanics 86
Squaw Lake Alkalic Complex 63
Sturgeon Narrows Alkalic Complex 58
Vanessa Lake Intrusion 54
Andalusite
Knotted metasediments 38-39,71
Pelitic metasediments 8
Siltstone-argillite 38
Anderson Group 93
Anglo Canadian Gold Estates 92
Anglo Canadian Occurrence
D. Koval 92-93
Ankerite
Carbonate breccia 32
Quartz veins
Gold 93
Antiperthite
Flindt River Intrusion 51,53
Squaw Lake Alkalic Intrusion 65
Vanessa Lake Intrusion 51
Vista Lake Intrusion 51,52
Apatite
Granodiorite-monzonite 52
Arenite, arkosic 37
Argillite 5,37-38,97
Photo 39
see also Siltstone-argillite
Ash tuff, felsic to intermediate 22,27
Kink folds 69,71
Photo 22,70
Atwood, Mr. 88
Base metal massive sulphide deposits 2,3,74,101
Beckett, P. V. 75,78,81
Bedding
Sandstone 37
Siltstone-argillite 38
Beidelman, Mr. 88
Belmore Bay 87,96
Belmore Bay Mining Co. 87
Biotite
Amphibolite 18
Felsic to intermediate metavolcanics 19
Granodiorite-monzonite 52,53
Granodiorite-trondhjemite 48,51
Squaw Lake Alkalic Complex 60
Alkalic phase 65
Trondhjemite 50
Biotite schist, rusty-weathering
Chemical analyses 83
Border phase, hybrid
Squaw Lake Alkalic Complex 61,65-66
Bordun Mining Corp. Ltd. 81
Bordun Mining (Quebec) Ltd. 78,81
Boudinage structure 69

Amphibolite 18
Boundary deposit 2
Box fold
Photo 73
Breccia
Autoclastic flow
Mafic to intermediate metavolcanics ... 16
Carbonate
see Carbonate breccia
Micro
Sturgeon Narrows Alkalic Complex 56
Pillow
Mafic to intermediate metavolcanics 15-16
Photo 16,17
see also Hyaloclastite
Bucke, H. W. W. 78,81-82

Calcite
Carbonate breccia 32
Campbell, C. L. 82
Canadian Nickel Co. Ltd. 78,82
Can-Con Enterprises & Expl. Ltd.
St. Anthony Mine 75,78,82-86
Cancrinite
Squaw Lake Alkalic Complex 60
Alkalic phase 61,65
Canex Aerial Expl. Ltd. 100
Carbonate
Amphibolite 18
Boudinage structure 69
Flindt River Intrusion 53
Squaw Lake Alkalic Complex 65
Sturgeon Narrows Alkalic Complex 56
see also Quartz-carbonate
Carbonate breccia 6,29-36,95,102
Chemical analyses 34,35
Gold 74
Photo 31,32
Carbonate dikes 55-56
Carbonate zone
Gold 81
Sulphides 98
Cataclasis 68,72-73
Eastern Granitic Complex 49
Felsic to intermediate pyroclastic rocks 22
Photo 22
Squaw Lake Alkalic Complex 60
Sturgeon Narrows Alkalic Complex 55,56
Vista Lake Complex 52
see also Faulting
Chalcopyrite
Quartz veins
Gold 83,87,88,93,101
Silver, gold, copper 96
Charlesbois, C. P. 82
Chartrand, A. 100
Chilled margins 9,30,31,43,44,54
Chlorite
Carbonate breccia 35
Felsite 29
Granodiorite-monzonite 52,53
Granodiorite-trondhjemite 48
Metavolcanics 59,60
Squaw Lake Alkalic Complex 65
Chloritoid
Felsic to intermediate metavolcanics 19
Metavolcanics 101
Chromium
Carbonate breccia 36
Conglomerate 40,42,57
Pebble
Photo 41
Conwest Expl. Co. Ltd. 78,86-87,97
Copper
Quartz-carbonate veins 74
Carbonate breccia 35
Quartz vein
Gold 88,95,96
Cote, Andre 100
Couture Lake 6,13,17,51,81,82,83,93,97,99
Coveney Island 6,20,37,39,41,42,57, 70,75,77,81,100
Coveney Lake 22,86
Creek deposit 2
Crenulation 68
Micro 71
Cromorr Mines Ltd. 93
Cross bedding
Felsic to intermediate fine tuff 23
Siltstone-argillite 38
Cross folds 70,71

Davidson Carr occurrence
Johnson, S. 75,87-88,89,90
Dawson Gold Mines Ltd. 96
Dawson-White Gold Mines Ltd. 96
Dawson-White occurrence
Pomac Mines Ltd. 74,75,95-96
Diorite 6,8,44
Porphyritic 44-47
Dolomite
Ferroan
Carbonate breccia 32
Quartz-carbonate veins 74

East Bay 38,39,41,42,56,66,71,74,75,77,97
Eastern Granitic Complex 48-49,67,72
English River Gold Mining Co. Ltd. 95
Epidote
Feldspathic pods-veinlets 44
Stringers
Eastern Granitic Complex 49
Eskers 66
Exploration work, summary of
Table 78-80

Fairburn, W.H 82
Falconbridge Nickel Mines Ltd.
Lyon Lake property 74

Faulting 68,72-73
  Sturgeon Narrows Alkalic Complex 55,56
  see also Cataclasis
Feldspar
  Augens
    Vanessa Lake Intrusion 53
    Vista Lake Intrusion 52
  Felsic to intermediate pyroclastic rocks 20
  Flindt River Intrusion 53
  Metavolcanics 59,60
  Squaw Lake Alkalic Complex 60,65
  Trachytoidal texture 69
Feldspathic dikelets
  Eastern Granitic Complex 48
Feldspathization 55,57
Felsite 29
Fenitization 8
  Squaw Lake Alkalic Complex 59
  Sturgeon Narrows Alkalic Complex 37,55,57
Flaser structure
  Felsic to intermediate tuff 27
Flindt River 67,94
Flindt River Intrusion 8,52-53
Flow banding
  Sturgeon Narrows Alkalic Complex 56
Flow rocks, felsic to intermediate
  Breccia
    Chemical analyses 10-12
Flow rocks, mafic to intermediate
  Autoclastic breccia, vesicular & amygdaloidal 16
  Chemical analyses 10-12
  Massive 9
  Pillowed 13-16
    Photo 14,15,16,17
  Porphyritic 9,13
    Photo 13
Fluorite
  Sturgeon Narrows Alkalic Complex 76-77
    Syenitic rocks 81
Folding 70-72
  Eastern Granitic Complex 49
    Photo 71,72,73
  see also Kink folds; Cross folds; Box folds; Slip folds
Foliation 68
  Felsic ash tuff
    Photo 22
  Squaw Lake Alkalic Complex 57
Fortier, Cyrille 75,78,87
Frazer, Mr. 93
Fraser Lake 28
Fuchsite
  Carbonate breccia 33,35

Gabbro 6,8,44,57
  Hornblende
    Chemical analyses 46-47
  Hornblende quartz
    Chemical analyses 46-47
  Porphyritic 44-47
  Porphyritic anorthositic 44-47
    Chemical analyses 46-47
    Photo 45
  Tremolite-rich quartz
    Chemical analyses 46-47
Galena
  Gold 74,83,87,95,101
Garnet
  Amphibolite 18
  Squaw Lake Alkalic Complex
    Hybrid border phase 61
Glacial striae 66
Glendinning, G. 82
Gneissic structure
  Amphibolite facies rocks 68
  Granodiorite-trondhjemite 49,68
Gold 74,75
  Carbonate zone 81
  Porphyry dikes 50
  Quartz-carbonate veins 74,93
    Carbonate breccia 35,36
  Quartz veins 3,50,81,87,88,93, 94,95-96,100,101
Gold-silver 3,74,75,82-86,87,101
Gold-silver-copper 96
Golden Centre Mining Co. 88
Golden Spur Syndicate Ltd. 92
Graded bedding
  Carbonate breccia 32
    Photo 32
  Felsic to intermediate tuffs 23,24,25,26,27
  Sandstone 37
Granges Expl. AB option
  Spooner Mines & Oils Ltd. 80
Granges Expl. AB 98
Granitic rocks 8,48-54
  Chemical analyses 54
  Gold
    Quartz veins 74
Grannis, F. H.
  Symmes occurrence 78,87
Granodiorite 48-54
  Amphibole-biotite 50
  Biotite 48,50
  Chemical analyses 84,86
  Garnet 61
  Hornblende 51-52
  Hornblende-biotite 48,51-52
  Quartz-lenticule 49,71
Graphite
  Argillite 38
  Iron formation 94
Greenschist facies
  Felsic to intermediate metavolcanics 18-19
  Gabbro-diorite 44-45
  Mafic to intermediate metavolcanics 9
  Metasediments 36-37
  Squaw Lake Alkalic Complex 60
Greenstone schist
  Chemical analyses 83
Group F deposit, Mattagami 2

Hannula, L. 78,87
Helicitic structure
  Knotted metasediments 40
Hematite
  Granodiorite-monzonite 52
  Granodiorite-trondhjemite 49
Hornblende
  Amphibolite 18
  Granodiorite-monzonite 52,53
  Granodiorite-trondhjemite 48
  Squaw Lake Alkalic Complex
    Alkalic phase 65
    Border phase 66
  Trondhjemite 50
Hornblende hornfels facies
  Vista Lake Intrusion 51
Huronian Belt Co. 87
Hyaloclastic deposit
  Carbonate breccia 29,33,35
Hyaloclastite (Pillow Breccia) Units 15-16
  Photo 16,17

Inclusions, mafic
  Squaw Lake Alkalic Complex 59,61
  Sturgeon Narrows Alkalic Complex
    Photo 56
Intrusive rocks
  Felsic 48-54
    Chemical analyses 54
  Intermediate & alkalic 54-66
    Chemical analyses 58-59, 62-64
    Photo 56
  Mafic 43-47
    Chemical analyses 46-47
    Photo 45
Iron formation, sulphide 40-43,67,76,86,94,97
Iron-titanium oxides
  Carbonate breccia 33
  Gabbro-diorite 44
Isolated breccia unit 30-32
  Chemical analyses 34

Jack Lake Gold Mining Co. Ltd. 82
Johnson, S.
  Davidson Carr occurrence 75,78,87-88,89,90
  Powell occurrence 78,88,91

Kerr Addison Mines Ltd. 78,88,92
Kerr Lake Mining Co. Ltd., The 82
King, Mr. 93
King, Peter 3
King Bay 49,50,81,86,93,97,98
Kink folds-faults 68,69-70,71
  Photo 70
Knotted metasediments 38-40
Koval, Donald 79
  Ouillette Mines Ltd. 75
  Anglo Canadian occurrence 92-93
Kratzendein, Benjamen 79,93

Lake Agassiz, glacial 66
Lamellae, deformation
  Quartz
    Photo 22
Laminations
  Felsic to intermediate fine tuff 24,25,27
  Flow
    Squaw Lake Alkalic Complex 60
Lamprophyre dike
  Squaw Lake Alkalic Complex 61
Lapillistone, felsic to intermediate 22,27
  Agglomerate
    Photo 41
  Figure 24
  Photo 21
Lapillistone-tuff, felsic
  Figure 26
Lapilli-tuff, felsic 27
  Figure 24,26,27
Larchmont Mines Ltd. 79,93
La Riviere property 95,96
Layered breccia, subunit 30,35
  Chemical analyses 34
  Photo 32
Layering, compositional & textural
  Squaw Lake Alkalic Complex 60
  Sturgeon Narrows Alkalic Complex 56
Lediet, William 82
Leucosyenite 55
Lineaments
  see Faulting
Lineation 69
  Flow
    Squaw Lake Alkalic Complex 60
Lithologic units
  Table of 7
Lundberg, Hans 93
Lyon Lake deposit
  Mattagami Lake Mines Ltd. 2
Lyon Lake property
  Falconbridge Nickel Mines Ltd. 74

Magee Lake 97
Magnetite
  Felsic to intermediate ash tuff/wacke ... 22,77
  Gabbro-diorite 44
  Squaw Lake Alkalic Complex 60,61,65,77
Mattabi Mines Ltd. 2,19,74,101
Mattagami Lake Mines Ltd. 2,3,74,79,93-94
McRae Mining Corp. Ltd. 79,94
  Davidson Carr Occurrence 88,94
Metasediments 6,36-43,68
  Ferruginous 37
  Graphitic argillaceous 97
  Knotted 38-40,71
  Photo 38,39,41,42,73
  See also Argillite; Conglomerate; Iron Formation; Sandstone; Siltstone
Metavolcanics 8-36
  Carbonate breccia unit 29-36

Felsic to intermediate 6,18-29
Chemical analyses 10-12
Figure 24-27
Photo 21,22,23
Gneissic structure 68
Iron formation 40,43
Mafic
Chemical analyses 86
Gold source 74,84
Sulphides 76,96
Mafic to intermediate 5-6,9-18
Chemical analyses 10-12
Inclusion 30
Photo 13,14,15,16,17,31
Miarolitic cavities
Squaw Lake Alkalic Complex 60
Sturgeon Narrows Alkalic Complex 57
Miaskitic
Intermediate & alkalic intrusive rocks 54
Micaceous minerals
Metasediments 36
Knotted 38
Michell Lake 22
Microcline
Granodiorite-monzonite 52,53
Granodiorite-Trondhjemite 48,51
Squaw Lake Alkalic Complex
Alkalic phase 65
Border phase 65
Trondhjemite 50
Migmatite
Eastern Granitic Complex 49
Vanessa Lake Intrusion 54
Mixed breccia subunit 30
Chemical analyses 34
Photo 31
Mobilizates, feldspathic
Eastern Granitic Complex 48
Monzonite 51,53-54,61
Moraines
Ground 66
Ridges 66
Morgan Island 6,16,17,19,20,31,32,69,92, 94,100,101
Mud Lake 87
Mudstone 37,42
Muscovite
Granodiorite-trondhjemite 51
Mylonitic texture
Felsic to intermediate pyroclastic rocks 22
Myrmekite
Felsic to intermediate porphyry 28

Nepheline
Squaw Lake Alkalic Complex 61
Alkalic phase 61
Sturgeon Narrows Alkalic Complex 55,57
New Brunswick Uranium Mining & Metals Ltd. ..74
Nickel
Carbonate breccia 36
Niobium 77
Nipigon Bay 15,16,100
North Arm 5,49,50,66,81-83,87,94-99
Northeast Arm *passim*
Northeast Arm - Sturgeon Narrows fault zone ..69
Aeromagnetic data 67
Faulting - cataclasis 68,73
Northern Gold Reef Ltd. 82
Northern Light Mine 96
O'Flaherty, K. 79,94

Omar Expl. Inc. 79,94
Ouilette Lake 17,96,97
Ouillette Mines Ltd.
Koval, D. 75,92

Pacaud, Bennett 81
Parasitic (drag) folds 71
Patricia Ice Mass 66
Pegmatoids
Eastern Granitic Complex 49
Vista Lake Intrusion 52
Radioactivity 77
Perthite
Squaw Lake Alkalic Complex
Alkalic phase 65
Wacke 57
Phelps Dodge Corp. of Canada Ltd. 79,94-95,100
Phyllite
Photo 22,70
Pillow structures 6,9,13-16,32
Photo 13,14,15,16,17,31
Plagioclase
Amphibolite 18
Carbonate breccia 33
Felsite 29
Gabbro-diorite 44
Porphyritic 45
Photo 45
Granodiorite-monzonite 52,53
Granodiorite-trondhjemite 48,51
Metasediments 36
Porphyritic mafic to intermediate flow metavolcanics 9,13
Porphyry, felsic to intermediate metavolcanics 28-29
Quartz-eye feldspathic Wacke
Photo 38
Squaw Lake Alkalic Complex
Alkalic 65
Border 65
Sturgeon Narrows Alkalic Complex 57
Trondhjemite 50
Plastic deformation
see Soft sediment deformation
Pleistocene 66
Plications 71
Pomac Mines Ltd.
Dawson-White occurrence 75,79,95-96

Porphyry
Felsic to intermediate 28-29
Quartz-feldspar 28
Dikes (gold)
Western Granitic Complex 50
Quartz
Gold mineralization 83,88,92,93,100
Powell Occurrence
S. Johnson 88,91
Pyrite 101
Argillite 97
Carbonatized zone 98
Felsic to intermediate pyroclastic 76
Felsite 29
Graphitic argillaceous metasediments or tuffs 97,99,100
Graphitic schist 82
Iron formation 40-43,94,97
Quartz veins 92,99
Gold 82,83,87,88,93,95,100,101
Silver, gold, copper 96
Quartz-carbonate veins 74
Siliceous zone 76,98
Pyrite, copper
Quartz veins 92
Pyroclastic rocks
Felsic to intermediate 6,19-27,70
Figure 24-27
Photo 21,22,23,71
Sulphides 76,101
Mafic to intermediate 16-17
Pyroxene
Squaw Lake Alkalic Complex
Alkalic phase 65
Pyrrhotite 101
Argillite 97
Carbonatized zone 98
Graphitic argillaceous metasediments or tuffs 97,99,100
Graphitic schist 82
Iron formation 40-43,94,97
Siliceous zone 76,98

Quartz
Boudinage structure 69
Carbonate breccia 33
Felsic to intermediate pyroclastic rocks 20,22
Felsite 29
Photo 22
Porphyry 28-29
Granodiorite-monzonite 52,53
Granodiorite-trondhjemite 48,57
Lenticules
Granodiorite-trondhjemite 49
Massive
Silver, gold, copper 96
Metasediments 36
Squaw Lake Alkalic Complex 65
Trondhjemite 50
Quartz-carbonate veins
Gold (copper) 35,74,75,76,93
Quartz-feldspar porphyry 28
Quartz monzonite 48,53-54,57-60,61,65-66
Chemical analyses 86
Garnet 61
Quartz veins
Gold 74,75,81,83,84,87,88,93,94,95-96,100,101
Quaternary 66
Quest Lake 55

Radioactivity 77
Recent 66
Richelieu Gold Mines Ltd. 92
Rowland, E. R. 79,96
Royex Mining Ltd. 79,96-97
Ryan, C. J. & Assoc. 93

St. Anthony Dev. Co. Ltd. 82
St. Anthony Gold Mines Ltd. 3,83
St. Anthony Gold Mining Co. Ltd. 82
St. Anthony Mine 3,50,51,74,75,82-86,101
St. Anthony Pluton 51,74
Sandstone 37
Saussurite
Gabbro-diorite 44
Schistosity 68
Scobie, W. 79,86,97
Seaton Island 57
Selco Expl. Co. Ltd. 42,80,86,97-98
Sericite
Squaw Lake Alkalic Complex 65
Sericite schist
Wallrock
Gold 83-84
Chemical analyses 84
Seseganaga Lake 49
Shore occurrence
Steep Rock Iron Mines Ltd. 75
Silica
Squaw Lake Alkalic Complex 61
Sturgeon Narrows Alkalic Complex 57
Siliceous zone
Sulphides 76,98
Siltstone-argillite 37-38
Iron formation 40,41,43
Kink folds - faults 70
Photo 38,39,72
Silver
see Gold-silver
Silverside Mines Ltd. 80,98
Slickensides 69
Slipfolds 71
Flexural 70,71
Photo 72
Slump & scour structures
Felsic to intermediate tuff 23,27
Sodalite
Squaw Lake Alkalic Complex
Alkalic phase 61

Soft sediment deformation
Iron formation 41
Photo 73
Siltstone-argillite 38
Photo 39
Sphalerite
Gold 74,83,95,101
Gold-silver 87
Sphene
Granodiorite-monzonite 52
Spherulites
Felsic tuff 28
Spooner Mines & Oils Ltd.
Granges Expl. AB option 80,98
Squaw Lake Alkalic Complex 8,57-66,70,73
Aeromagnetic data 67
Chemical analyses 62-64
Trachytoidal texture 69
Steele, J. 82
Steep Rock Iron Mines Ltd. 80,98-99
Shore occurrence 75
Steine, M. 80,99
Stilpnomelane
Carbonate breccia 30,33,35
Felsic to intermediate metavolcanics 19
Sturgeon Lake Dev. Co. 82
Sturgeon Lake Mines Ltd. 2
Sturgeon Lake Mining Co. Ltd. 95
Sturgeon Narrows 74,86
see also Northeast Arm - Sturgeon Narrows
Sturgeon Narrows Alkalic Complex 8,37,55-57,73
Aeromagnetic data 67
Chemical analyses 58-59
Fluorite 76-77,81
Photo 56
Radioactivity 77
Trachytoidal texture 69
Sturgeon Narrows Structural Zone 8
see also Northeast Arm-Sturgeon Narrows Fault Zone
Sturgex Mines Ltd. 40,80,97,99
Sulphides 76
Ferruginous metasediments 37
Iron formation 40-43,76,94,97
Siliceous zone 76,98
Siltstone-argillite 38
see also Pyrite; Pyrrhotite; Chalcopyrite; Galena; Sphalerite; Graphite
Sulphide deposits, base metal massive
see also Base metal massive sulphide deposits
Sulphide zone, graphitic 5,101
Syenite 55,60
Fluorite 81
Leuco 55
Pegmatoid 65
Radioactivity 77
Photo 56
Syenite porphyry
Perthite 57
Syenodiorite 55
Syenogabbro 55
Syenomonzonite 61
Natrolite-biotite-perthite 61
Nepheline (Alkalic) 57,60-61,65
Quartz 57,60,65-66
Symmes occurrence
F. H. Grannis 87
Synformal fold 68
Synclinal structure
Vista Lake, Flindt River & Vanessa Lake Intrusions 51

Tay River Mines Ltd. 80,99
Theriault, Albert 100
Theriault, Arthur et al. 80,95,100
Theriault, Frank 100
Thunder Mining Co. Ltd. 82
Titanium
Carbonate breccia 36
Tourmaline
Quartz veins
Gold 87,93
Trachytoidal texture
Squaw Lake Alkalic Complex 60,69
Sturgeon Narrows Alkalic Complex 56,69
Trap Lake 45
Trondhjemite 51
Amphibole 61
Amphibole-biotite 50
Biotite 48,50
Biotite-garnet 61
Chemical analyses 86
Chlorite-biotite 48
Hornblende-biotite 48
Massive 50
Porphyritic 50
Gold 76
Quartz-lenticule 49,71
Tuff
Felsic to intermediate 19-27
Chemical analyses 10-12
Figure 24-27
see also Ash tuff
Mafic 68
Tuff-breccia, intermediate to felsic 22,27
Chemical analyses 10-12
Photo 21,23
Figure 24,26
Tuff/Flow, felsic to intermediate
Chemical analyses 10-12
Tuff, lithic-crystal ash
Mafic to intermediate metavolcanic 17
Tuff/Porphyry, felsic to intermediate
Chemical analyses 10-12
Tuff, spherulitic
Felsic 28

Uranium 77
Utica Mines Ltd. 80,100

Vanessa Lake 13,43,66,67,70,76,81, 94,97,99,100
Vanessa Lake Intrusion 8,53-54,68
Chemical analyses 54
Vesicles
Mafic to intermediate pillowed flow 13,16
Photo 15,17
Vista Creek 82
Vista Lake .40,43,48,49,67,69,72,73,76,94,97,99
Vista Lake Intrusion 8,36,51-52,67,68
Radioactivity 77
Volcanogenic sedimentary rocks 36
see also Carbonate breccia

Wacke 57
Cherty 37
Ferruginous volcanogenic
Felsic to intermediate metavolcanics ...22
Lithic feldspathic 37
Quartz-eye feldspathic 37
Photo 38
Wallrocks
Squaw Lake Alkalic Complex 59
Sturgeon Narrows Alkalic Complex 55
Weathering, differential
Photo 32
Wellington Lake 82
Western Granitic Complex 49-50,76
Western Quebec Mines Co. Ltd. 80,100
Wettlauffer-Lorrain Co. 82
Wisconsin stage 66

Zeolites
Squaw Lake Alkalic Complex
Alkalic phase 61
Zinc, copper, lead, silver, gold 2
Zincblende
Gold 87
Zonation
Carbonate breccia 32
Plagioclase 45,65
Photo 38
Porphyritic gabbro-diorite 45,47
Squaw Lake Alkalic Complex 61

MAPS NOT

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